Proposed TMDLs

Econfina-Fenholloway River, Ocklawaha River, and St. Marks River Basins

Dissolved Oxygen

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Region 4

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INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The 1998 303(d) list, submitted to EPA by the FDEP, identified waterbodies within the state which are impaired by one or more pollutants. Seven of those waterbodies, WBID 2688 Hatchet Creek, WBID 2769 Daisy Creek, WBID 2740A Ocklawaha River above St. Johns River, WBID 3573B Steinhatchee River, WBID 3473C Fenholloway River above the Pulp Mill, WBID 3603 Bevins (Boggy) Creek, and WBID 793A St. Marks River, are listed for low dissolved oxygen. Figures 1 and 2 show the WBID locations. This report presents the Total Maximum Daily Loads (TMDLs) for Dissolved Oxygen (DO) for the waters set out above.

The TMDLs addressed in this document are being proposed pursuant to EPA commitments in the 1999 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998) that TMDLs be developed for all of the impairments on the approved 1998 303(d) list (the 1999 Consent Decree).

EPA reviewed water quality data for the seven waterbodies addressed in this TMDL and concluded that the waterbodies contained concentrations of dissolved oxygen that are below Florida's statewide water quality standard for dissolved oxygen. EPA also reviewed other information such as land cover and land use and potential for anthropogenic impacts from point and nonpoint sources and concluded that the low dissolved oxygen in these waters is due to natural conditions. As set out more fully below, the low dissolved oxygen does not appear to be caused by any anthropogenic sources of pollutants into these streams, as there are no or very small anthropogenic sources on any of the streams. Rather, the natural background conditions of these waters, considering the natural load of oxygen demanding substances reaching the waters together with seasonal low flows, results in naturally depressed dissolved oxygen.

Florida's water quality standards allow for the Florida Department of Environmental Protection to establish site specific alternative criteria for dissolved oxygen where the failure to meet the statewide water quality standard is due to natural background. Such

site-specific criteria have not been established for these waters, however, so the applicable water quality standard remains the statewide standard of no less than 5 mg/l dissolved oxygen.

The 1999 Consent Decree sets out a schedule for the proposal and establishment of TMDLs in the State of Florida. The Waterbody Identification Units (WBIDs) described in this TMDL were identified in the 1999 Consent Decree as WBIDs scheduled for TMDL development by EPA by September 30, 2003. While EPA has determined that the low dissolved oxygen levels are likely the result of natural conditions, the waters are not attaining the applicable water quality standard of no less than 5 mg/l dissolved oxygen. Therefore, EPA is proposing these TMDLs to comply with the requirements of the 1999 Consent Decree.

Since the entire load of oxygen demanding substances in these waters comes from natural background conditions, no control strategies are contemplated to address the impairments. The TMDL provides for zero allocations to any anthropogenic sources, whether point sources or nonpoint sources, unless or until the State establishes and EPA approves site specific alternative criteria for the waters. At that time, both the impairment status of these waters and this TMDL should be reevealuated.

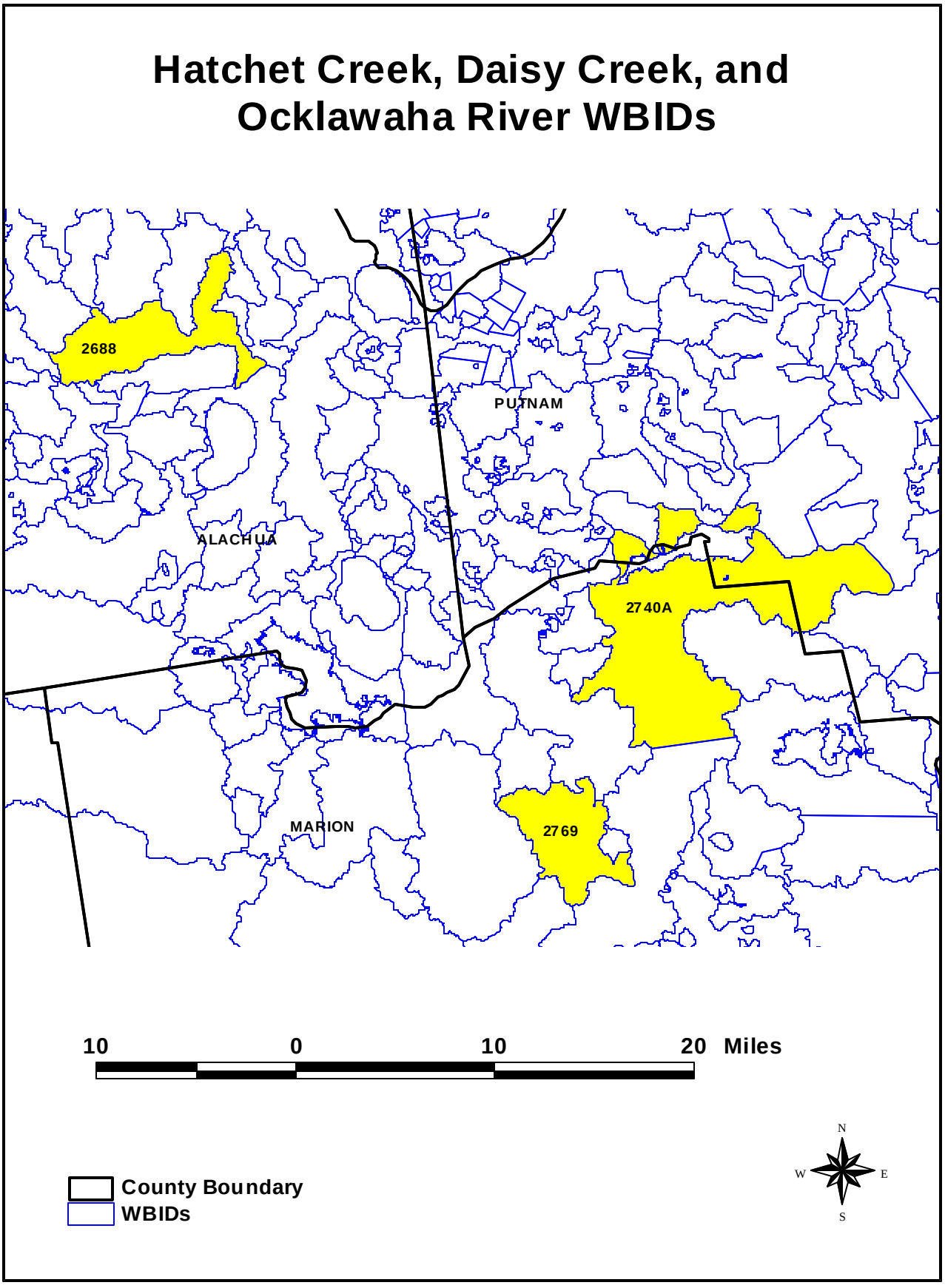

Figure 1. Ocklawaha Basin WBIDs

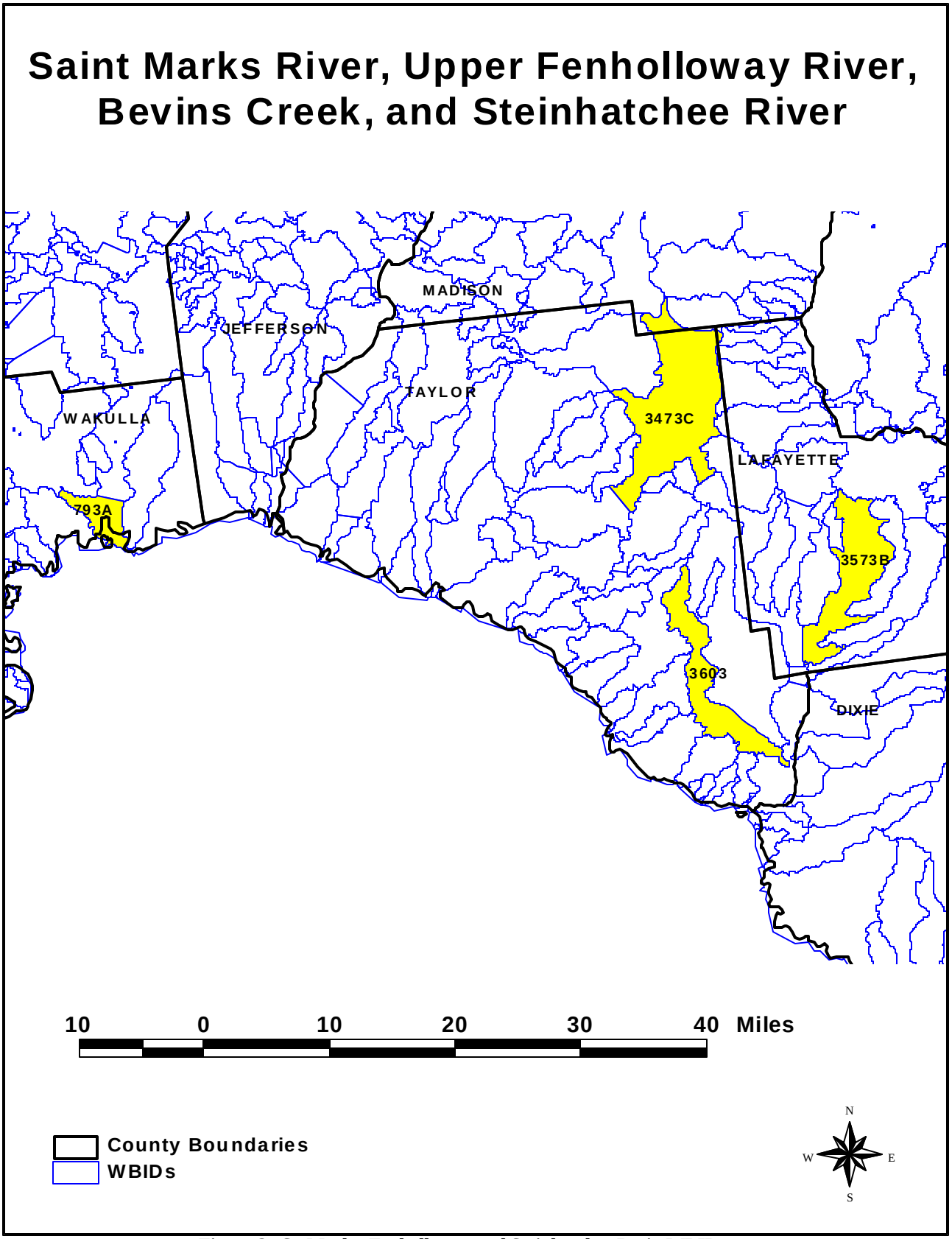

Figure 2. St. Marks, Fenholloway and Steinhatchee Basin WBIDs

WBID #2688 Hatchet Creek

Dissolved Oxygen

Hatchet Creek (WBID 2688), located in Alachua County, is classified as a Florida Class III fresh water, which implies the designated uses of recreation such as fishing and swimming. Land use data from 1995 NLCD coverage indicates Hatchet Creek is primarily forest, rangeland, wetlands and barren (94 percent), and only 3 percent agricultural and 2 percent residential. Hatchet Creek is listed on the 303(d) for low DO and EPA is responsible for developing the TMDL pursuant to the Consent Decree.

Data from water quality stations listed in Table 1 were used in the assessment of this impaired water body. The water quality data for this WBID show 36 violations of the DO criteria out of 65 measurements and this indicates that a TMDL is necessary. However, a more detailed review of the information shows that most of the DO violations occurred in 1999 and 2000, which were extremely dry years. In fact, all of the DO violations occur at very low stream flow, flows less than about 2 cfs. Total phosphorus (TP) concentrations were markedly higher during the dry years of 1999 and 2000. The TP concentrations were 0.184 and 0.161 mg/l in 1999 and 2000, respectively, about two times higher than the concentrations of 0.086, 0.099 and 0.110 mg/l in 1996, 1997 and 1998.

In streams impaired by low DO a cause for the low DO must be identified in order to address the problem. In urban areas loads of biological oxygen demanding material (BOD) from point sources and resulting sediment oxygen demand (SOD) loads are common causes of low DO in receiving streams. Excessive nutrients can also contribute to DO depletion through algae and plant growth and decay. In Hatchet Creek there are no point sources of oxygen depleting substances. This fact turns the attention to watershed and in-stream BOD loads, watershed nutrient loads and the relationship between these loads and low DO in the stream.

Water quality data are shown in Figure 3 through Figure 7. The water quality data show low DO and chlorophyll measurements commonly above 20 ìg/l, mainly in the dry years of 1999 and 2000. As shown in Figure 4, DO levels less than 5.0 mg/l occur when the flow is less than about 2 cfs. Nutrient levels are not excessive with average nitrate/nitrite of 0.014, ammonia of 0.037 mg/l (see Figure 66), and total phosphorus of 0.15 mg/l (see Figure 7). The statewide averages are 0.1, 0.04 mg/l and 0.09 mg/l for nitrate, ammonia and total phosphorus, respectively (Ocklawaha Basin Status Report, DEP, Nov. 2001). Sources of nutrients include watershed runoff, groundwater, and leaking septic tanks.

Low DO occurrences in Hatchet Creek are most likely due to very dry conditions under which the stream is not flowing and only stagnant pools are present. The warm temperatures promote algae and plant growth and decay, which ultimately results in pools of very low DO water. In addition, Hatchet Creek is a black water stream characterized by warm water temperatures, low stream gradient, riparian swamps, and darkly stained

water from tannins that color the water. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands, periods of low dissolved oxygen naturally occur in these streams that drain the wetlands areas.

An attempt to model water quality in Hatchet Creek proved fruitless due to the shallow depths, low velocities, low flows, and insensitivity to the low watershed pollutant loads. The stream flow data includes 332 days of zero flow and 43 days of no data. Since the low DO occurs during these extended periods of low and zero flow, these periods need to be captured in the modeling analysis for it to be helpful. However, estimates of reaeration and other parameters vital to representing this system are inaccurate and actual values are unknown.

There are no point sources of oxygen demanding pollution to Hatchet Creek and the observed low DO can be attributed to extremely dry or zero flow conditions. Hatchet Creek is a black water stream in which low DO is common. Landuse in Hatchet Creek is predominantly undeveloped forest and wetlands. In addition, a Stream Condition Index (SCI) assessment of Hatchet Creek scored excellent as reported in the Ocklawaha Basin Status Report (DEP, Nov. 2001). An excellent score means that biological communities are healthy.

Florida DEP developed a nutrient TMDL for Newnan's Lake, which receives flow from Hatchet Creek. In the TMDL, DEP characterizes the landuse for the entire Hatchet Creek watershed as 87 percent forest, range, and wetlands, 6.5 percent residential and transportation, and 4.6 percent agriculture (Dr. Xueqing Gao, and Douglas Gilbert, July 2003). Landuses in the Hatchet Creek watershed contributed the following nitrogen load to Newnan's Lake: forest and wetlands sources up to 74 percent; residential, agriculture and other human use about 17.2 percent; and baseflow about 7.7 percent. The sources of total phosphorus are 55.1 percent forest and wetlands, 21.2 percent residential, agriculture and other human landuses, and 23.5 percent baseflow. The Newnan's Lake nutrient TMDL prescribes total nitrogen and total phosphorus loads reductions of 74 and 59 percent, respectively. These load reductions along with continued monitoring should further protect the designated uses of Hatchet Creek.

However, a reduction in SOD loading to this stream of 53 percent is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. This percent is determined by assuming: stagnant flow conditions; a saturated dissolved oxygen concentration of 7.6 mg/l at 30 degrees Celsius; and assuming the ratio of the dissolved oxygen deficit under critical conditions minus the deficit attaining water quality standards to the dissolved oxygen deficit under critical conditions estimates the SOD impact on water quality. The calculation of the percent SOD reduction necessary to meet water quality standards is presented below.

Percent SOD reduction = 100 * ((DO cd) – (DO criteria deficit)) / DO cd)

DO cd = 7.6 mg/l -2.0 mg/l = 5.6 mg/l

DO criteria deficit = 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)

As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 53 percent reduction of natural SOD loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

Table 1. Water quality monitoring stations in WBID 2688

Station number	Station Name	First Date	Last Date
21FLA 20020122	hatchet cr near Gainesville	08/28/1996	03/24/1997
21FLCEN 20020122	hatchet creek on s.r. 26 just upstream of newnan'	02/11/2002	02/11/2002
21FLGW 7462	Sjd-hs-1075	06/28/2000	06/28/2000
21FLSJWM 02240800	hatchet_creek_near_Gainesville	01/29/1999	11/06/2001
21FLSJWM HAT26	hatchet creek at sr26 upstream side of bridge (us	01/14/1999	09/20/2000
21FLSJWM02240800	hatchet creek near Gainesville	06/06/1995	11/20/1998
21FLSJWMHAT26	hatchet creek @ sr 26 nr newnans lake	05/24/1993	08/25/1993

Table 2. Summary of data for Hatchet Creek WBID 2688

Parameter	Obs	Max	Min	Mean	StDev	Violations	Florida Criteria
Dissolved Oxygen (mg/l)	65	8.99	0.59	4.95	2.17	36	5

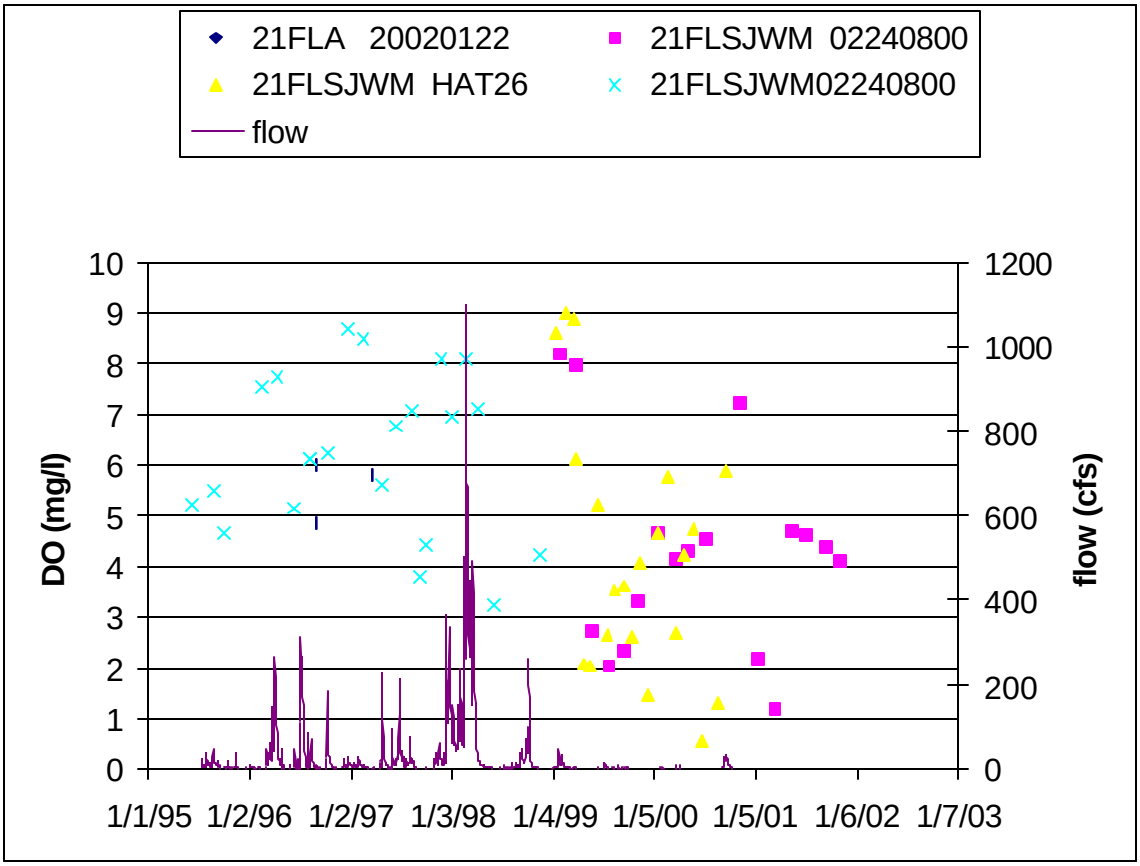

Figure 3. DO and Flow measurements in Hatchet Creek

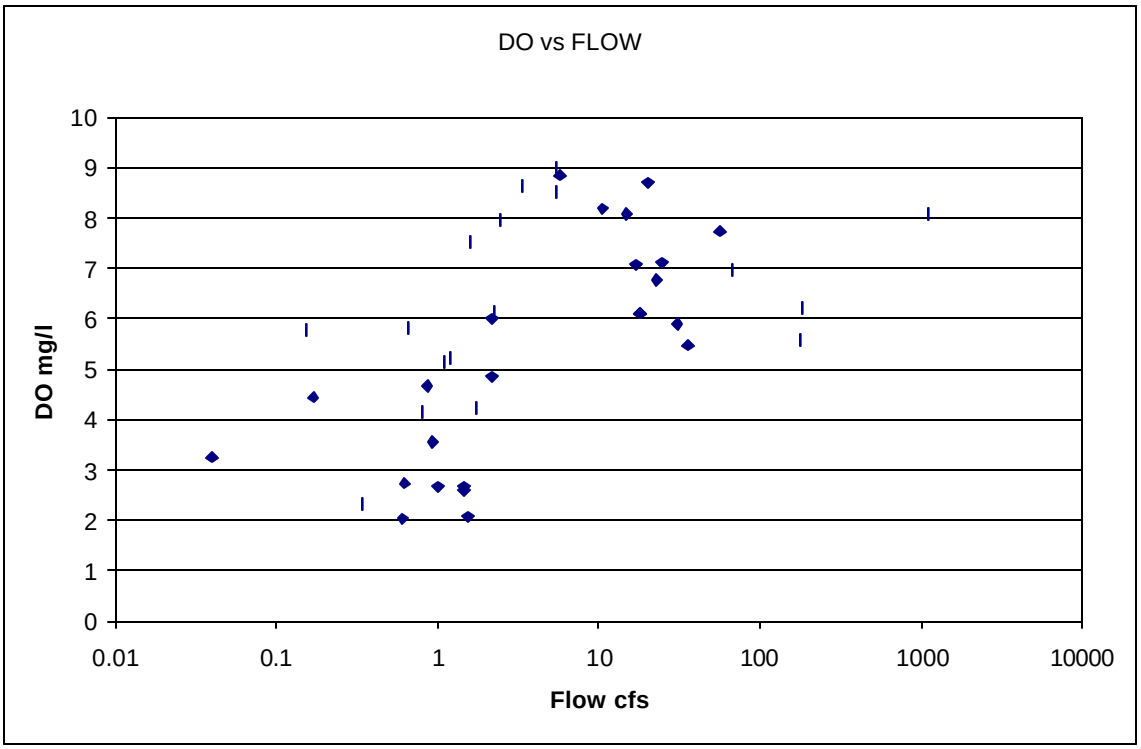

Figure 4. DO and flow measurements in Hatchet Creek

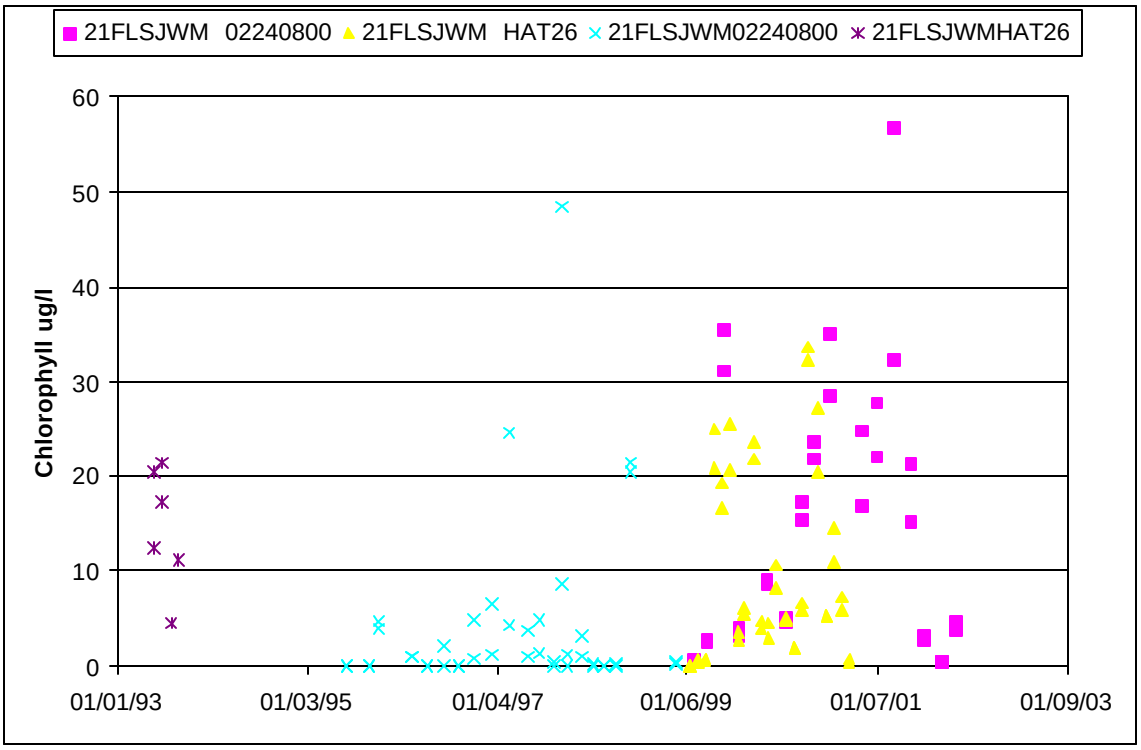

Figure 5. Chlorophyll measurements in Hatchet Creek

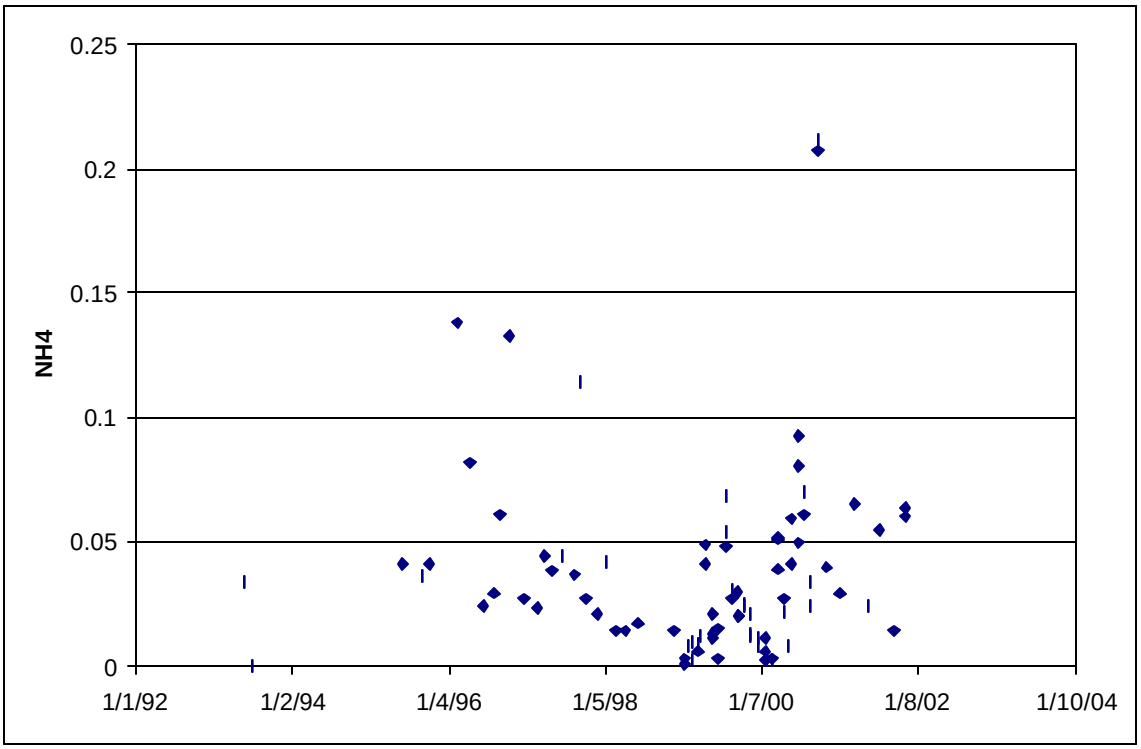

Figure 6. Ammonia concentrations measured in Hatchet Creek

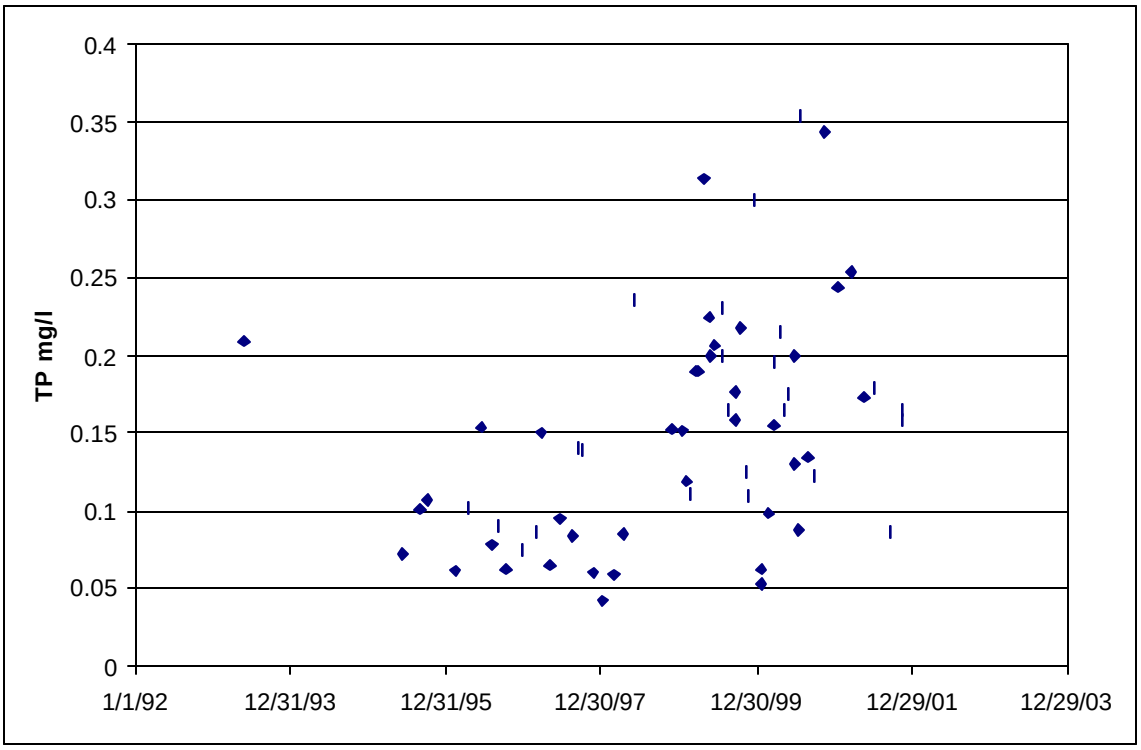

Figure 7. Phosphorus concentrations measured in Hatchet Creek

WBID #2740A Ocklawaha River above St. Johns River

Dissolved Oxygen

Ocklawaha River above St. Johns River (WBID 2740A) is located in Putnam and Marion counties. This segment of the Ocklawaha River begins downstream of Rodman Reservoir, WBID 2740B, and continues to the St. Johns River. Figure 8 is a picture of the river as viewed from Highway 19. The segment is on the 303d list for DO impairment. Warm water temperatures, low stream gradient, and extensive riparian swamps, characterize this segment of the Ocklawaha River. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands, periods of low dissolved oxygen naturally occur in stream segments that serve as outflows and drain the wetlands areas.

Figure 8. Ocklawaha River near Hwy. 19

DEP's July 1999 Minibasin Study of the Ocklawaha River scored the Ocklawaha River downstream of Rodman Dam in the excellent category in its Stream Condition Index (SCI) evaluation. An excellent score means that biological communities are healthy. The habitat was considered optimal at 130 points out of 145. However, the Shannon-Weaver diversity index decreased by 40 percent from a sampling station upstream of Rodman Dam and this station below the dam. This represents a violation of the Class III surface water quality standard for biological integrity, which prohibits a diversity decrease greater than 25 percent. The diversity was depressed at the site below the dam due to the large number of the caddisfly, Hydropsyche sp. Such caddisflies are often found in large densities below impoundments, predominantly related to growth and export of algae from the impoundment. The report continues to explain that other sampling showed no decrease in diversity, and that the overall community health was excellent at this site.

There are no NPDES facilities discharging in this WBID. Data from the water quality stations listed in Table 3 was used for the assessment and modeling analysis for this water body. Stations 21FLA 20020068, 21FLA 20020071, and 21FLGFWFGFCCR0214 are just downstream of the dam and represent the upstream portion of this river segment. Stations 21FLA 20020070, 21FLCEN20020070, and 21FLSJWMOR019 are near highway 19 and represent the water quality near the midpoint of this river segment, and station 21FLSJWMOCKLRM is near the mouth of the Ocklawaha River and represents the water quality at the downstream end of this river before it empties into the St. Johns River.

Table 3. Water quality observation stations used in assessment for WBID 2740A

Station number	Station Name	First Date	Last Date
11COEJAX3CFB10002	oklawaha river at sr 19	06/15/1989	09/26/1990
21FLA 20020068	ocklawaha river 1.1 mi. downstream rodman dam	02/23/1998	05/18/1999
21FLA 20020070	oklawaha river at sr 19	02/27/1989	05/18/1999
21FLA 20020071	oklawaha river downstream of rodman dam	11/27/1989	01/26/1998
21FLA 20020447	oklawaha river upstream of st. johns river	09/18/1989	09/18/1989
21FLCEN 20020068	ocklawaha river 1.1 miles downstream of rodman dam	01/05/1999	05/04/1999
21FLCEN 20020070	ocklawaha river at sr 19	01/05/1999	05/04/1999
21FLGFWFGFCCR0214	oklawaha river in rodman reservoir tailrace	01/03/1989	03/20/1989
21FLSJWMOCKLRM	ocklawaha river 1 mile upstream of mouth	12/30/1996	06/26/2002
21FLSJWMOR019	ocklawaha river @ hwy 19	05/17/1993	08/18/1993

Water quality data collected in the WBID are summarized in Table 4. As shown in this table, DO concentrations fell below the Florida water quality standard of 5.0 mg/l 63 times (24%) in the period from January 1995 to present.

Table 4. Summary of dissolved oxygen monitoring data in the Ocklawaha River WBID 2740A.

Parameter	Obs	Max	Min	Mean	StDev	Violations	Florida Criteria
Dissolved Oxygen (mg/l)	256	10.70	1.21	6.23	1.70	63	5

Water quality data are shown in Figures 9 through 16. The data in Figure 9 show that releases from the dam are not usually low in DO; therefore, the low DO must be a result of in-stream processes. As shown in Figure 10 and Figure 11, DO is observed at all concentrations at all times of the day; however, most sampling occurred between 9 AM and 2 PM during daylight hours when plants are producing oxygen, and low DO is common. Figure 12 illustrates the seasonal pattern of BOD concentrations measured in WBID 2740A. Ammonia observations are relatively low with a long-term average of about 0.025 mg/l (see Figure 14). TKN nitrogen includes ammonia and organic nitrogen. Figure 14 and Figure 15 show that there is a large portion of organic nitrogen, which is expected in a stream with high organic matter. Total Phosphorous measured in the Ocklawaha River above St. Johns River is shown in Figure 16.

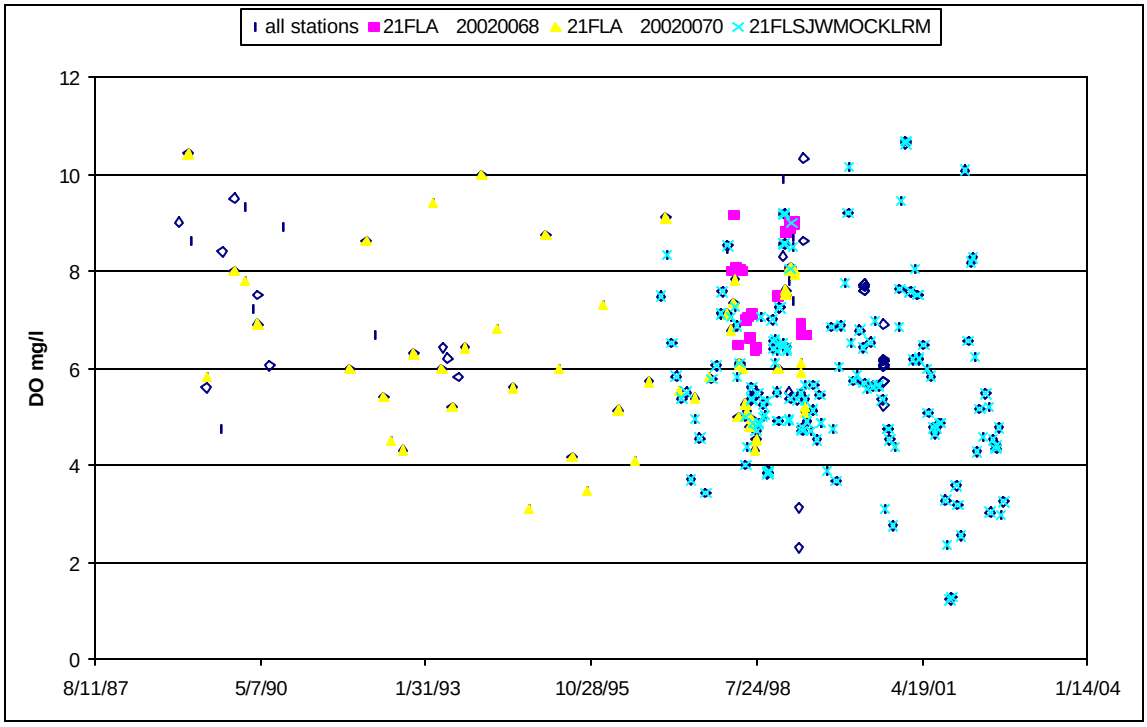

Figure 9. DO measurements at all stations in WBID 2740A

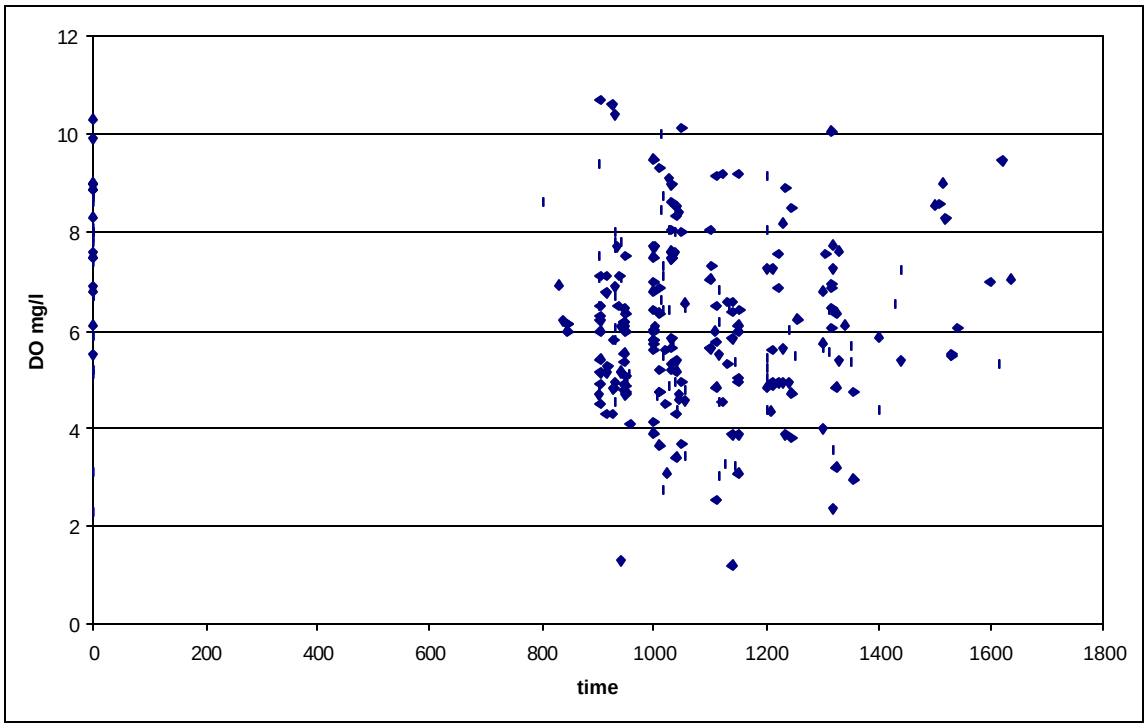

Figure 10. Variation in DO concentrations with time

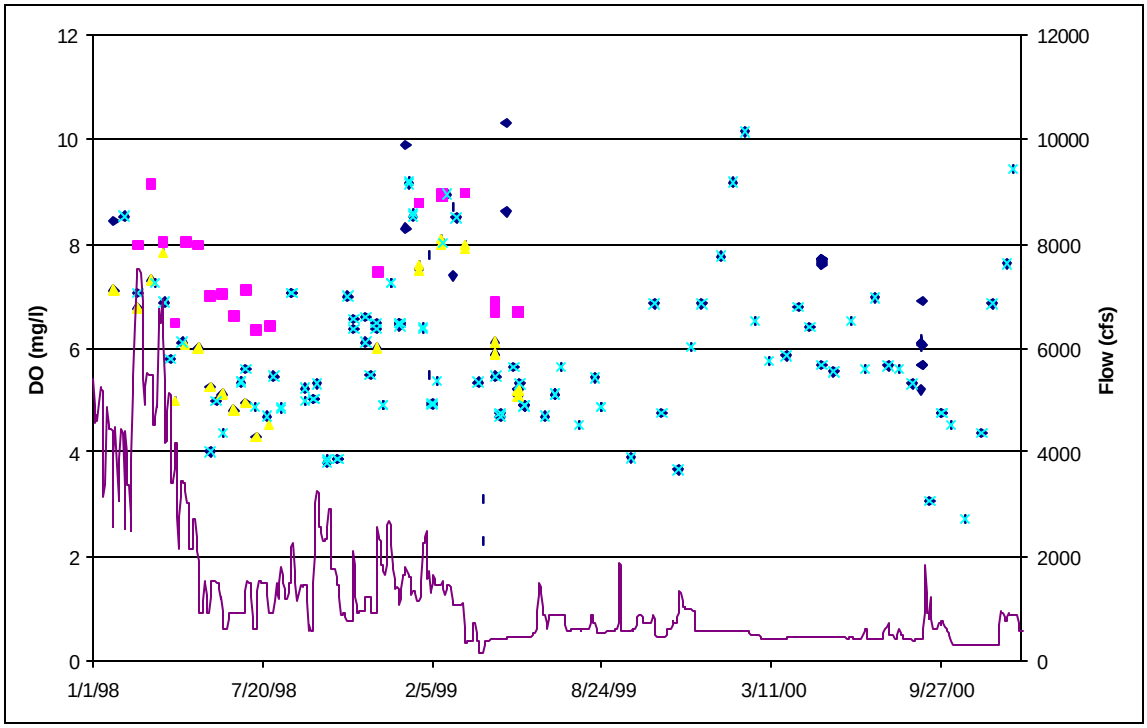

Figure 11. Variation of DO with flow

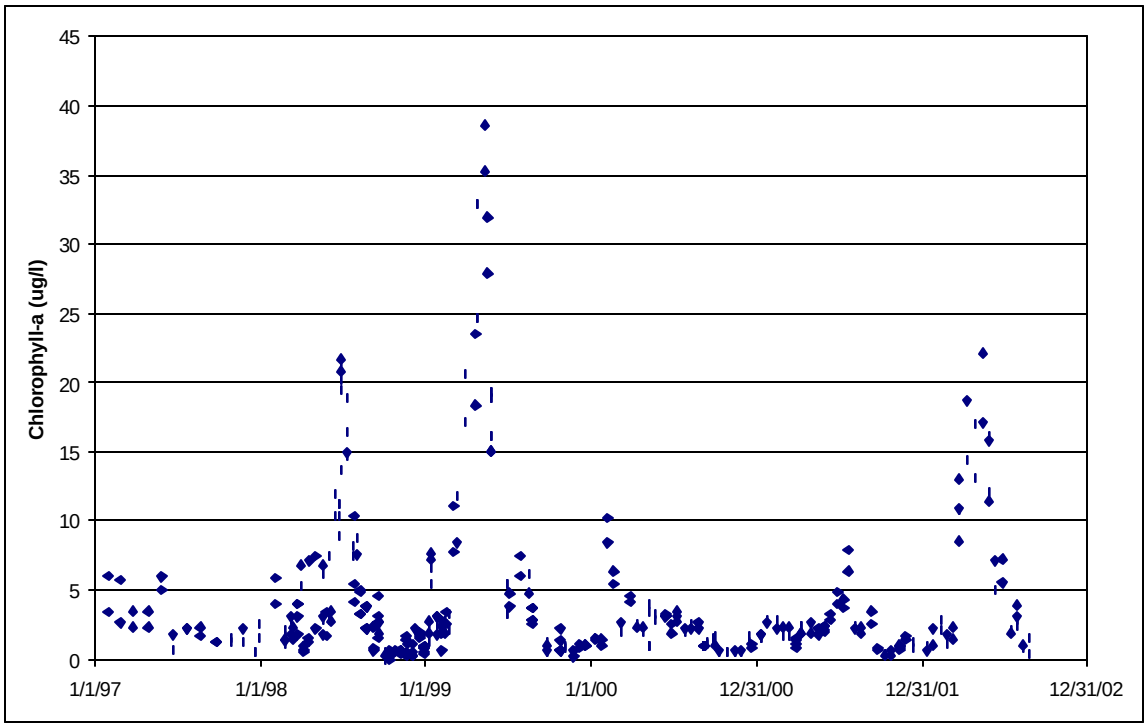

Figure 12. Chlorophyll-a measurements in WBID 2740A

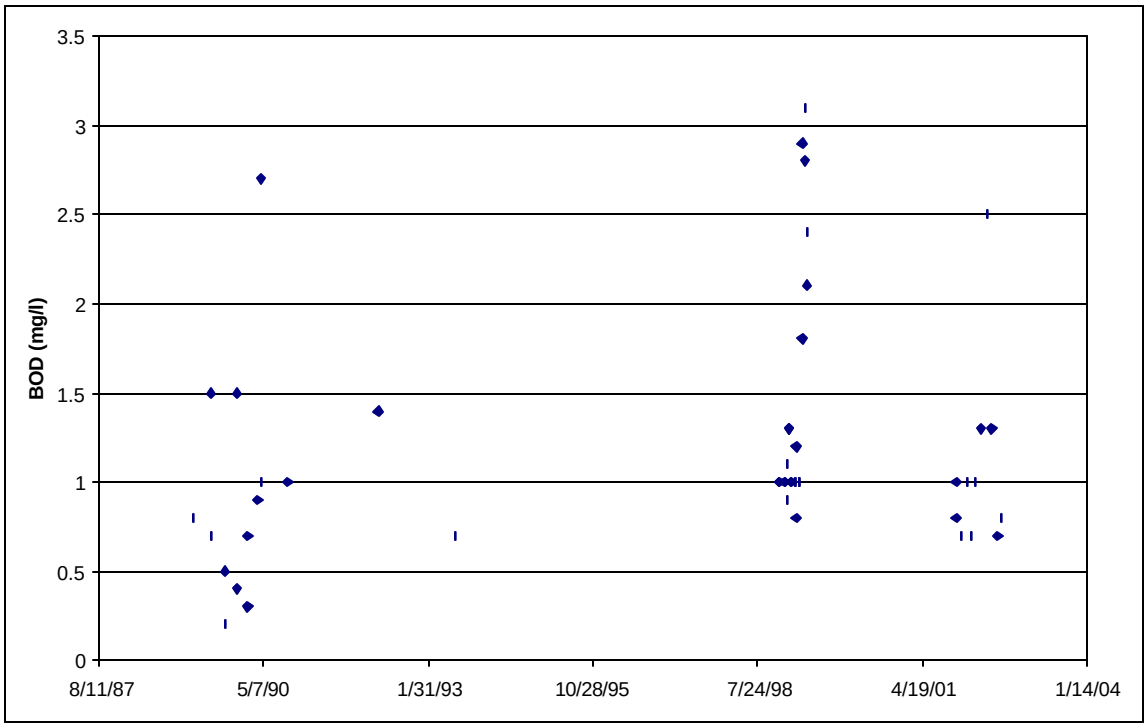

Figure 13. BOD concentrations measured in WBID 2740A

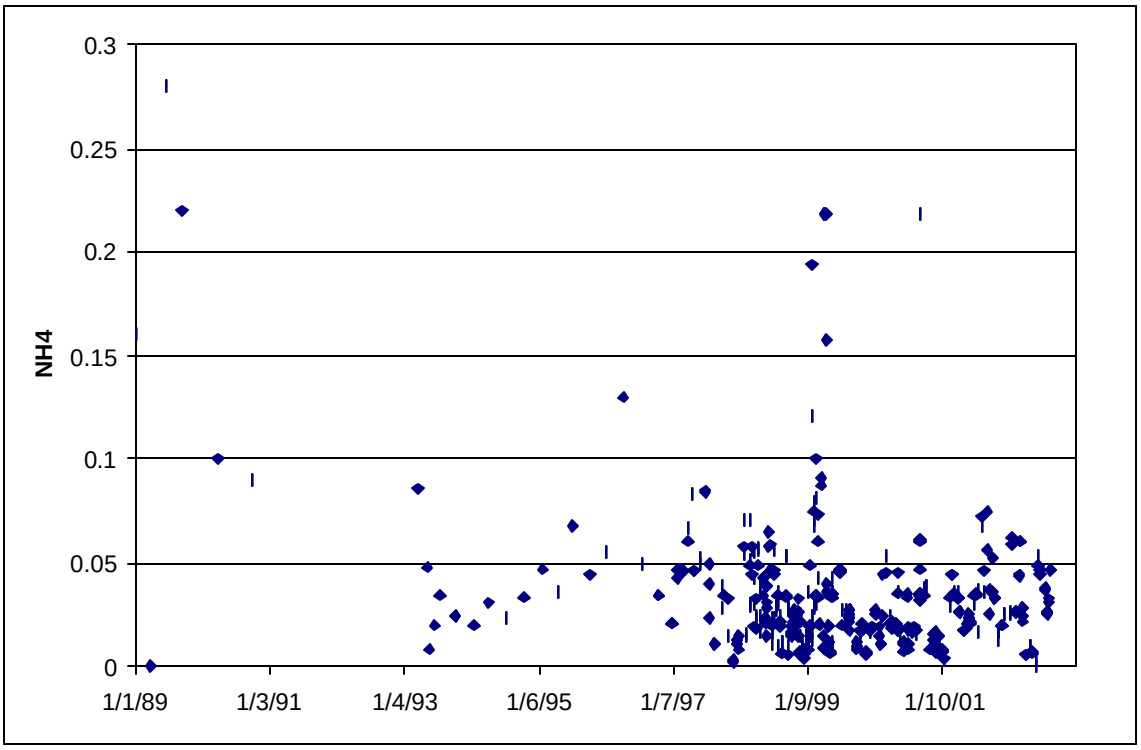

Figure 14. Ammonia concentrations at all stations in WBID 2740A

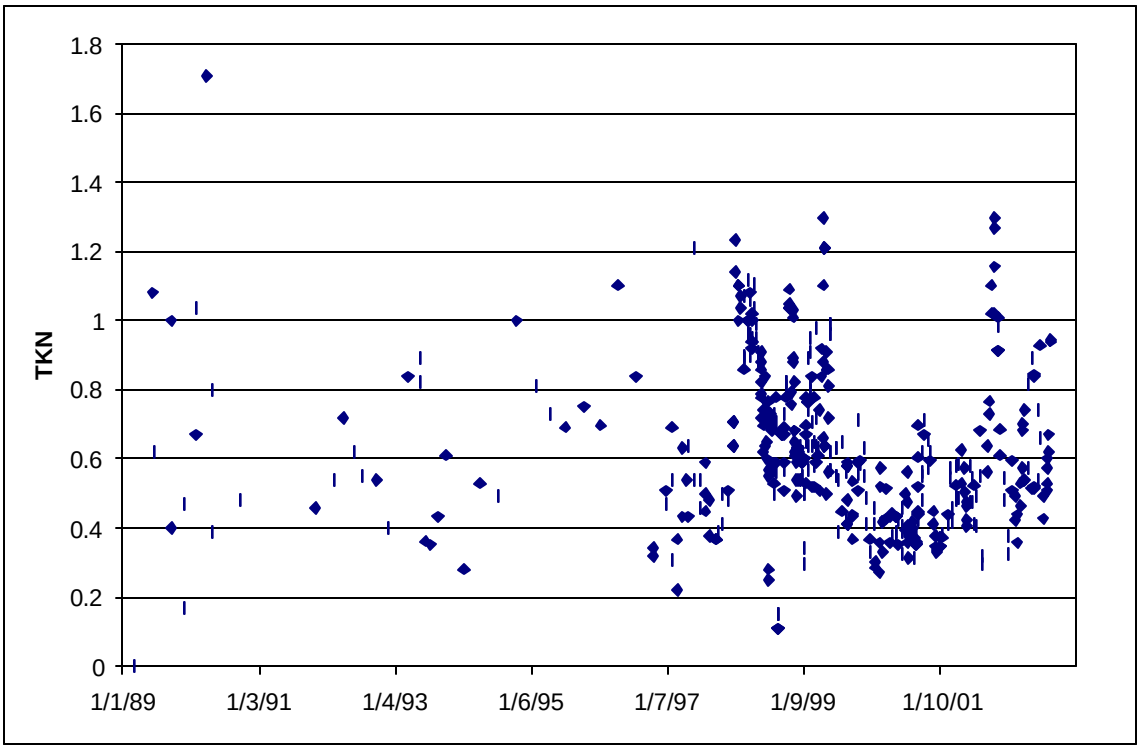

Figure 15. TKN Concentrations at all stations in Ocklawaha River above St. Johns

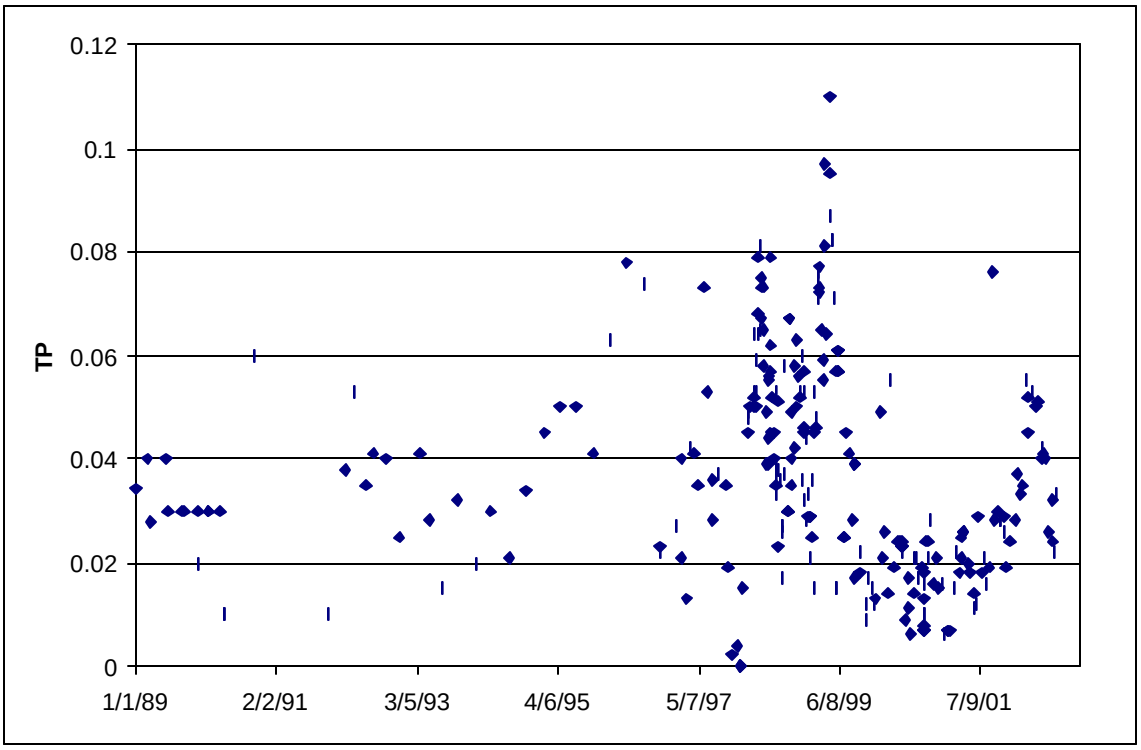

Figure 16. Total Phosphorous measured in the Ocklawaha River above St. Johns

The assessment of this WBID indicates it is a stream with high oxygen consuming demands from the surrounding swamp. Regular inundation of the swamp and draining into the river cause the low DO in the river. In addition, high oxygen demand from BOD in the form of organic matter and respiration from algae and other plants contribute to DO depletion. The DO depletion issue is compounded because the stream has little reaeration due to the low gradient.

For low dissolved oxygen, the sources include oxygen-demanding substances such as BOD. In addition, plant respiration depletes the DO in streams, and low DO is often associated with excessive nutrient enriched water bodies. In this WBID however, there are no point sources of nutrients or BOD. The closest point sources contributing to this water body are upstream of Rodman Reservoir, and are not considered to contribute to the impairment as this segment of the Ocklawaha River is downstream of Rodman dam.

Non-point sources are conveyed by overland flow and are evaluated by examining the landuse in the watershed contributing to the impaired stream. Land Cover in this WBID is about 4 percent residential and commercial, 1 percent agricultural, and 95 percent undeveloped forest and wetlands. Periods of low dissolved oxygen naturally occur in this stream segment because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands. Published studies have reported that this condition occurs in southern black water streams (Benke et al. 1984, Edwards and Meyer 1987, Hughes et al. 2000, Meyer and Edwards 1990, Reid et al 1976, USEPA 1986**).**

ANALYTICAL APPROACH

The PLOAD watershed loading model and the Water Quality Analysis Simulation Program version 6 (WASP6) model were used to evaluate the effect of BOD, nutrients, algae, and other oxygen demanding substances to water quality impairment. WASP6 is an enhancement of the original WASP model (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988). WASP6 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program.

Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP6 comes with two such models -- TOXI for toxicants and EUTRO for conventional water quality. Earlier versions of WASP have been used to examine eutrophication of Tampa Bay; phosphorus loading to Lake Okeechobee; eutrophication of the Neuse River and estuary; eutrophication and PCB pollution of the Great Lakes (Thomann, 1975; Thomann et al., 1976; Thomann et al, 1979; Di Toro and Connolly,

1980), eutrophication of the Potomac Estuary (Thomann and Fitzpatrick, 1982), kepone pollution of the James River Estuary (O'Connor et al., 1983), volatile organic pollution of the Delaware Estuary (Ambrose, 1987), and heavy metal pollution of the Deep River, North Carolina (JRB, 1984). In addition to these, numerous applications are listed in Di Toro et al., 1983.

The flexibility afforded by the Water Quality Analysis Simulation Program is unique. WASP6 permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions. The eutrophication module of WASP6 was applied to the Ocklawaha River in this study.

Water quality concentrations and temperature from the water quality stations near Rodman Dam were entered as the upstream boundary conditions. Flow from USGS gage station 02243960 near Rodman Dam was used for the flows. Depth and velocity data from the USGS was used to develop velocity to flow and depth to flow relationships for the WASP model. Solar radiation data were obtained on the University of Florida Institute of Food and Agricultural Sciences, Florida Automated Weather Network world-wide-web site http://fawn.ifas.ufl.edu/. The Apopka weather station data was used in this modeling project. Sediment oxygen demand (SOD) can be a major contributor to low DO. SOD measurements in nearby streams range from less than 1 to over 6 grams/square meter/day, (Sediment Oxygen Demand Rates, St. Johns River, May 2002) and (Hydroqual, Inc., Level II Water Quality Based Effluent Limitations for the Georgia Pacific Corp. Palatka Mill (Putnam County), March 1998-Final). Measured values of SOD in Rice Creek of 1.5 to 3.0 g/square meter per day were reported by Hydroqual (Hydroqual, Inc., Level II Water Quality Based Effluent Limitations for the Georgia Pacific Corp. Palatka Mill (Putnam County). Measurements in Rice Creek upstream of the Georgia Pacific Mill discharge range from 1.5 to 3.0; this area drains swampland similar to the Ocklawaha River below Rodman Dam. SOD rate of 1.5 was used in this WASP model for the Ocklawaha River segment. Incremental BOD and nutrient loads were entered into WASP from the results of the BASINS load estimation utility PLOAD.

PLOAD is a simple watershed model that computes nonpoint source loads from different subwatersheds and landuses based on annual precipitation, and landuses. Successful linking of the model to existing BASINS data and available data makes the model useful in estimating nonpoint source loads. PLOAD requires watershed boundary, landuse, point sources and annual precipitation data to compute pollutant loads. Additionally PLOAD requires event mean concentrations (EMCs) and/or loads per acre tables for different land use types. Since this watershed has no continuous point sources, PLOAD was selected to estimate annual loadings to feed the WASP eutrophication model. The model is based on the assumption that stormwater runoff is directly proportional to annual rainfall and is controlled by the percent of impervious land and the land runoff coefficients (USEPA, January 2001. PLOAD version 3.0 User's Manual).

Model Calibrations and Results

The WASP model was calibrated to observed DO and BOD data collected at the downstream end of the WBID at station 21FLSJWMOCKLRM near the mouth of the Ocklawaha River. Figures 17 through Figure 24 show the results of model calibrations and load reductions. Overall the model predicts water quality well. Although there are only a few observed Biochemical Oxygen Demand (BOD) data for the downstream station, the model predictions are in the correct range.

As shown in Figure 20, the model over predicts ammonia even with moderate watershed loads of 10 kg/day. This over prediction of ammonia may be due to the abundance of macrophytes in this segment of the Ocklawaha River. Ammonia nitrogen decreases due to the uptake by macrophytes and this process is not simulated in this model. The model slightly over predicts total phosphorus even with moderate watershed loads of 7 kg/day (see Figure 22). This can be explained by phosphorous uptake by the abundant macrophytes. Figure 23 illustrate that after a 40 percent reduction of pollutant loads the DO is frequently below 5.0 mg/l.

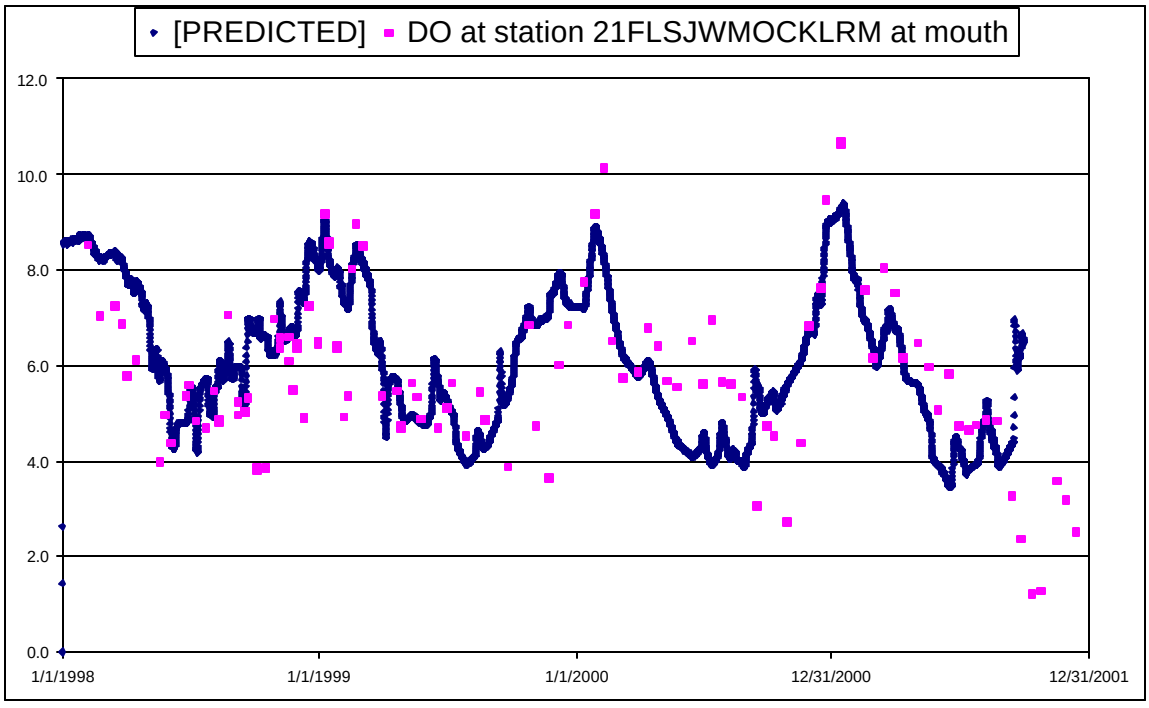

Figure 17. Predicted and observed DO concentrations at the mouth of the Ocklawaha River

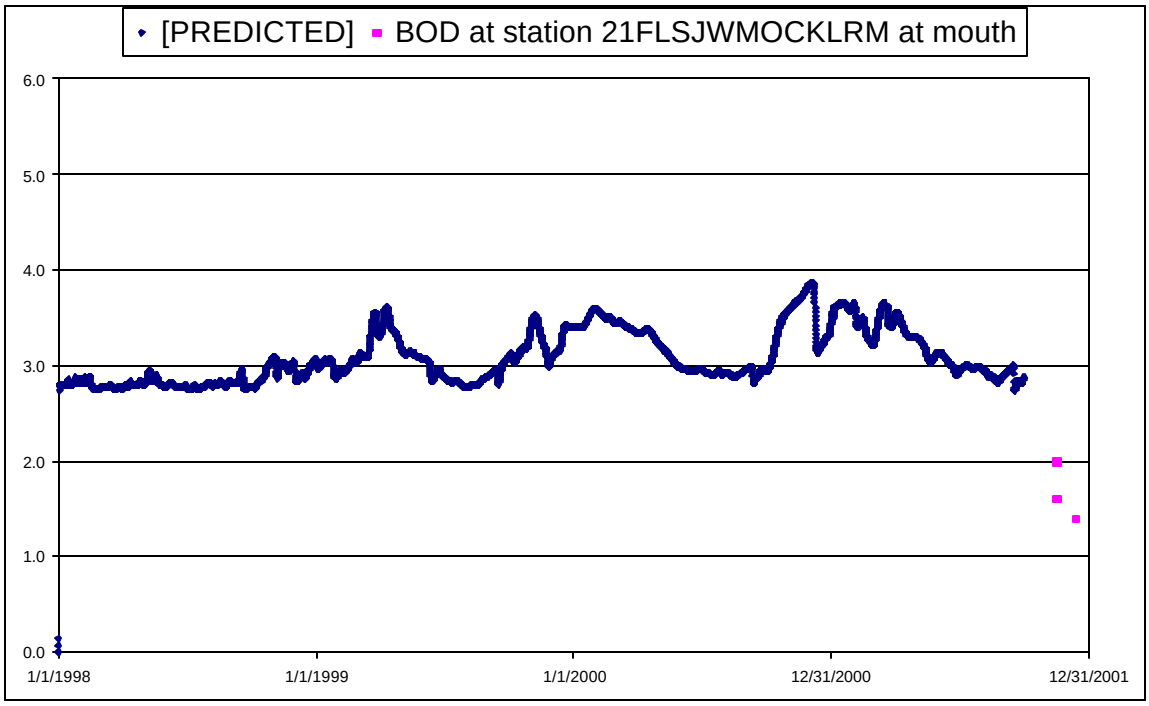

Figure 18. Predicted and observed BOD concentrations at the mouth of Ocklawaha River

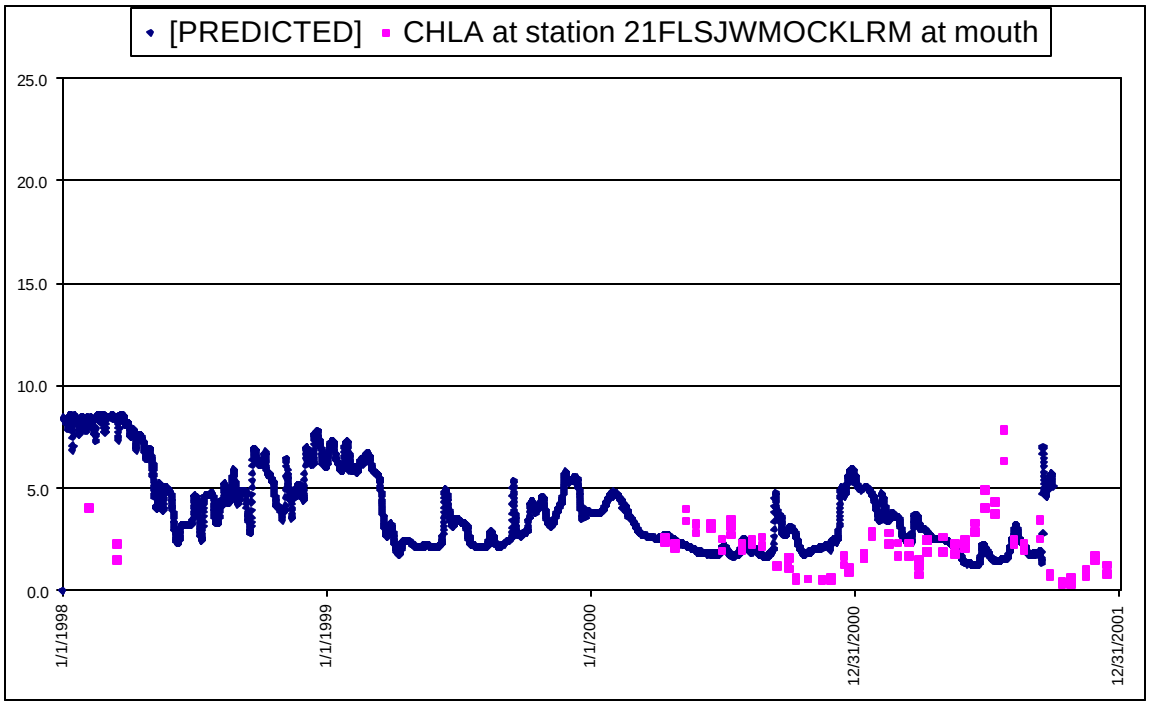

Figure 19. Predicted and observed chlorophyll measurements in Ocklawaha River

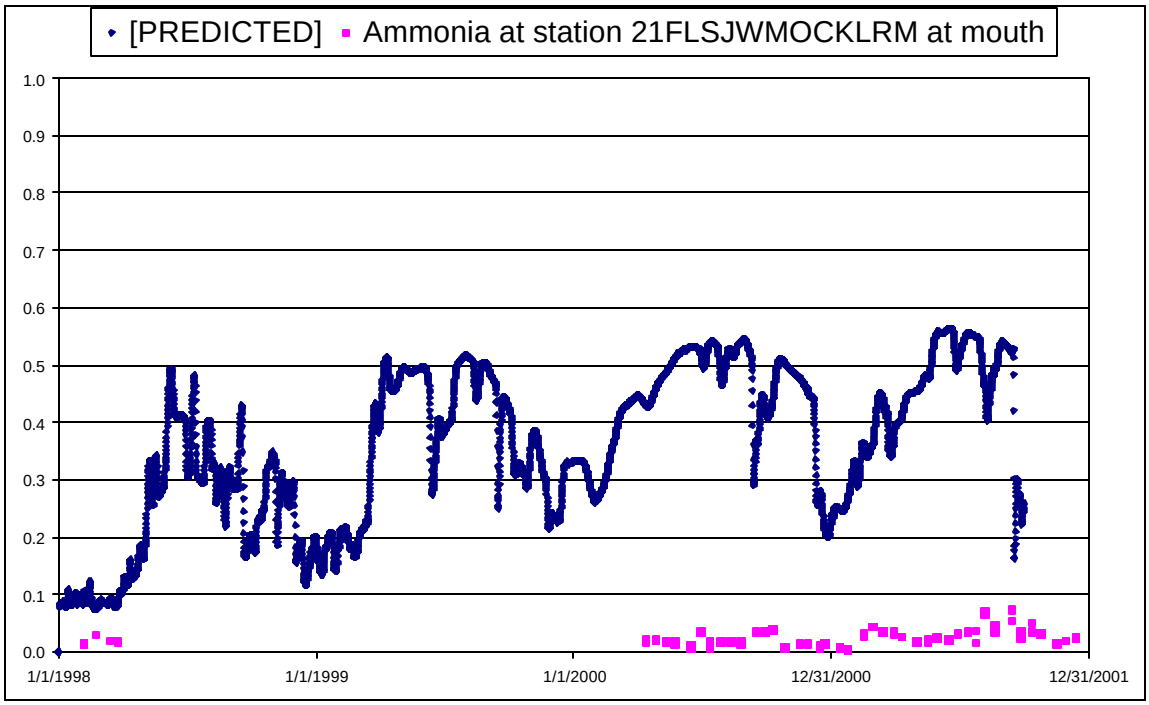

Figure 20. Predicted and Observed ammonia concentrations in Ocklawaha River

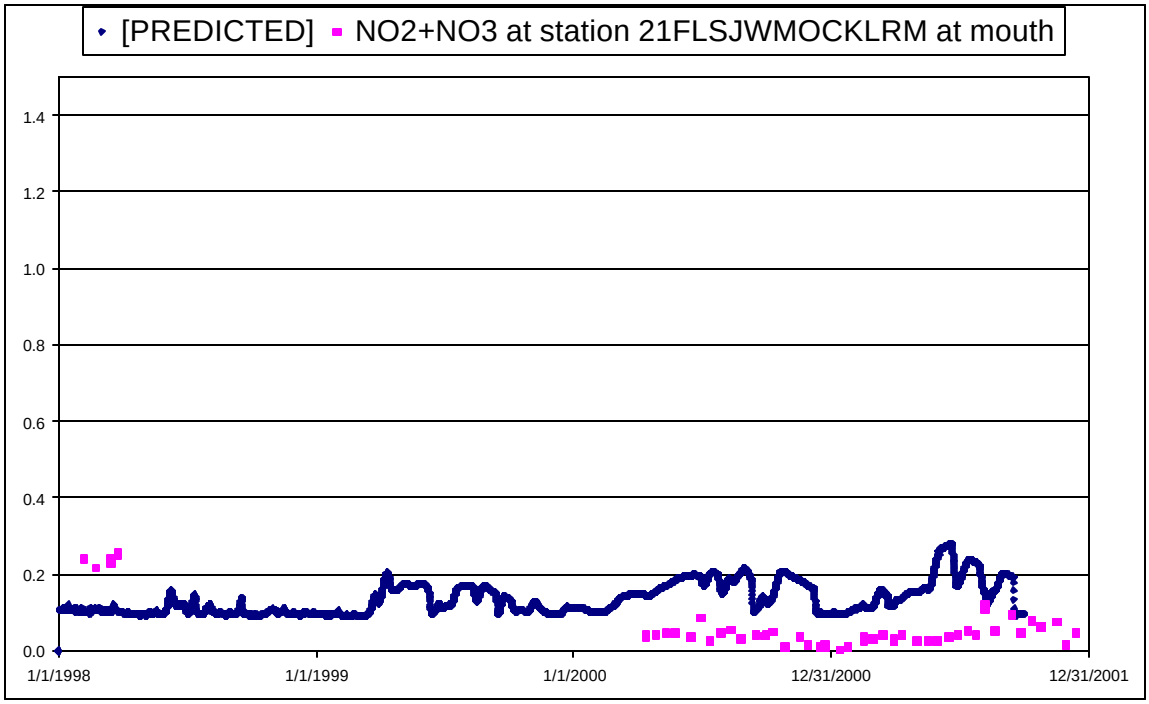

Figure 21. Predicted and observed nitrate and nitrite data in Ocklawaha River

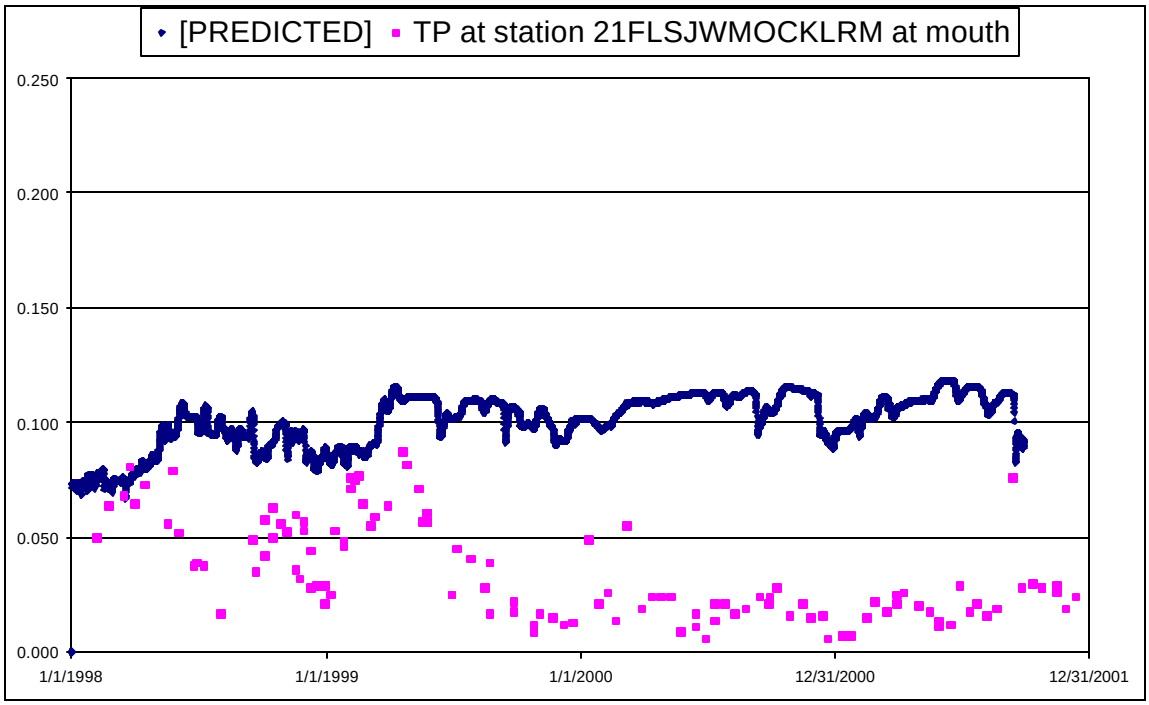

Figure 22. Predicted and observed total phosphorus concentrations in Ocklawaha River

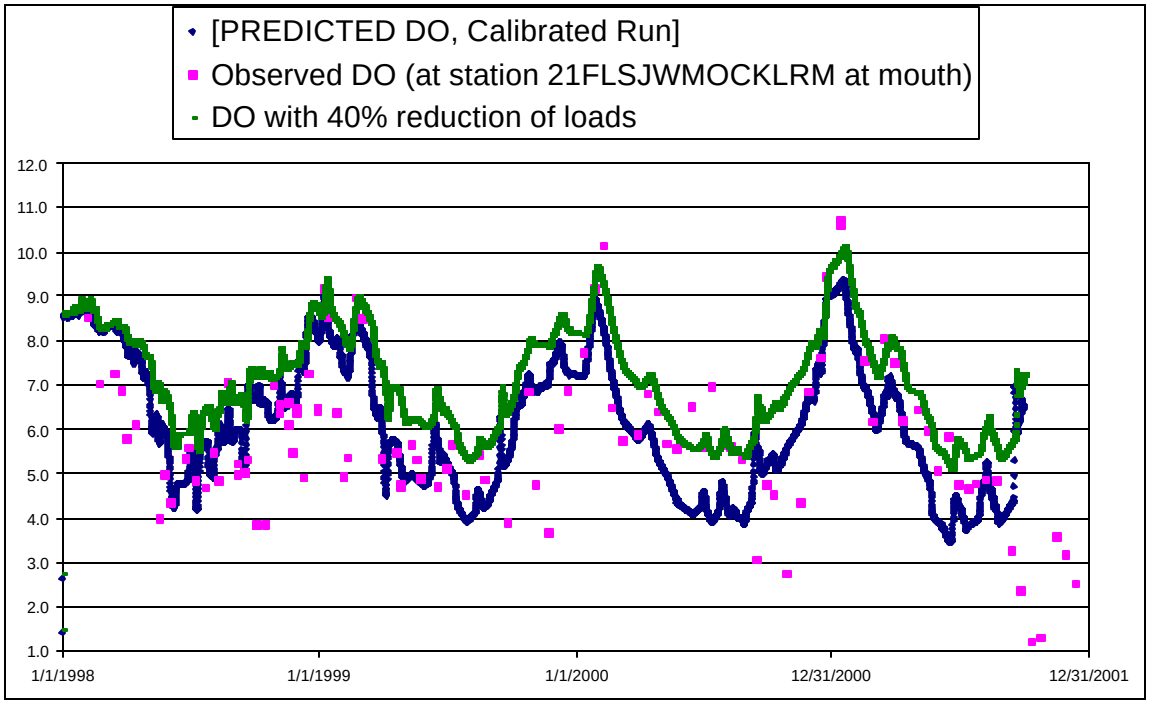

Figure 23. Predicted DO concentrations after 40 percent reduction in loads

Table 5. Watershed loads simulated in the model for existing conditions

loads in kg/day	BODult	TKN	Ammonia	Total Phosphorous	organic-N	ortho-P	organic-P
OCKLAWAHA RIV AB STJR	2338	41.24	10.15	6.91	31.09	3.45	3.45

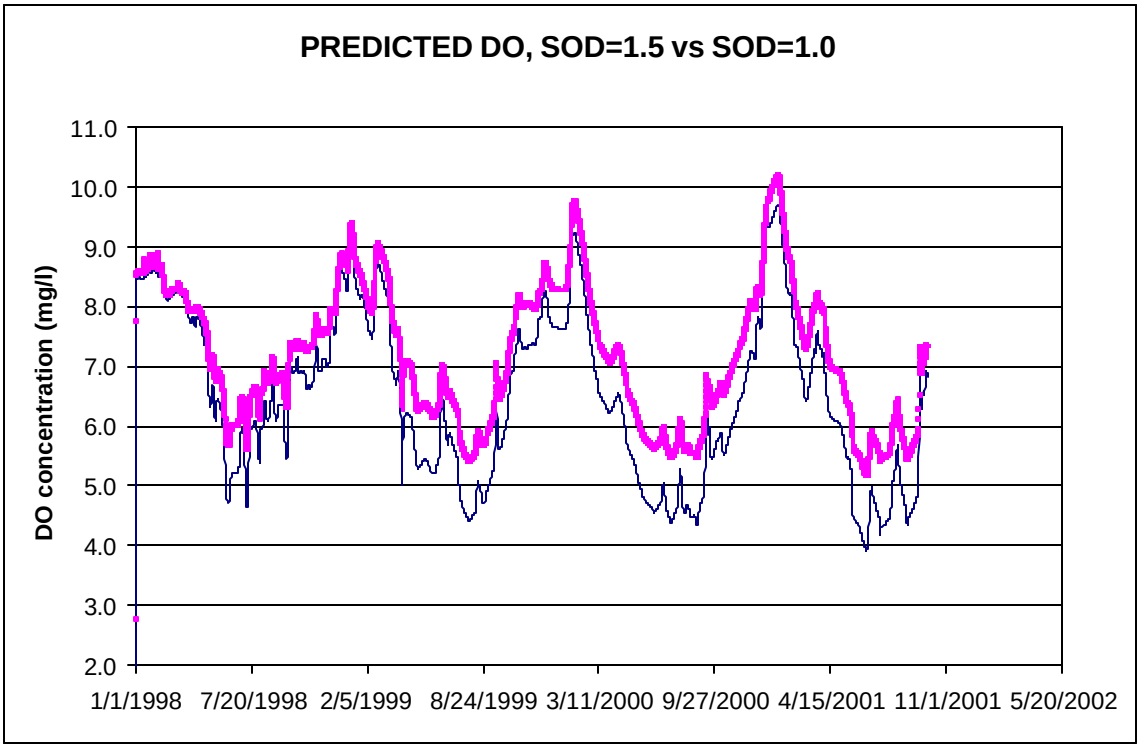

Figure 24. Model sensitivity to SOD concentrations

The model shows that the system is not very sensitive to the watershed loads, and a reduction of 90 percent improves the DO only slightly. The model indicates however, that the river system is sensitive to sediment oxygen demand. The water quality standard for DO can be achieved by reducing the incremental watershed loads by 90 percent and the sediment oxygen demand by 33 percent to 1.0 from 1.5 (see Figure 24). The reduction of watershed loads will reduce the SOD, however the interaction between in-stream loads and SOD is unknown. A reduction in SOD to 1.0 grams per square meter per day may not be reasonable since measured SOD rates in similar Florida streams are as high as 3.0

grams per square meter per day. In addition a 90 percent reduction of watershed loads in an area predominately forest and wetlands is not reasonable or achievable.

In summary, an assessment of water quality data and water quality model analysis suggest the low DO appears to be the result of natural in-stream and wetland processes including sediment oxygen demands. Reduction of the nutrient, BOD, and SOD loads from this predominately undeveloped forest and wetland system may not be practical or possible. Restoration projects in the Ocklawaha River watershed upstream of Rodman Dam have been implemented and may help reduce the oxygen demanding loads to this segment. Also, phosphorus reductions have been prescribed in the Florida DEP Lake Griffin TMDL.

A reduction in BOD loading to this stream of 90% is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 90 percent reduction of watershed loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

WBID #2769 Daisy Creek

Dissolved Oxygen

Daisy Creek is located in the Rodman Reservoir Planning Unit in Marion County. Daisy Creek is listed on Florida's 303(d) list for DO. Land cover in the watershed is predominantly forest with 83 percent forest and wetlands, 7 percent agriculture and rangeland, and about 11 percent residential, commercial and transportation. Urban development is occurring in the northwest portion of the watershed. Table 6 provides a list of water quality monitoring stations within the listed segment. Each station is identified and the time period of record is given for the individual stations. There are no NPDES facilities discharging to surface waters in the WBID.

Daisy Creek is a black water stream with average color of 378 Platinum-Cobalt Units. Black water streams are characterized by: warm water temperatures; low stream gradients; extensive riparian swamps; and darkly stained water from decomposing organic matter such as leaf litter. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands, periods of low dissolved oxygen naturally occur in these streams that drain the wetlands areas. These types of streams may have high oxygen demands from surrounding wetlands. Regular inundation of the swamp and draining into the river contribute to the

low DO in the stream. In addition, high oxygen demand from BOD in the form of organic matter and respiration from algae and other plants contribute to DO depletion. The DO depletion issue is compounded because the stream has little reaeration due to low gradient and extended periods of low or no flow. This stream has been dry for many years and 2002 was the first year since 1993 that water quality data is available. Out of 14 DO measurements, only 2 are above the Class III freshwater standard of 5.0 mg/l (see Figure 26). Average values for ammonia are 0.058, nitrate 0.053, TKN 1.66 mg/l indicating a large organic nitrogen component consistent with black water streams. As shown in Figure 27, the average chlorophyll–a concentration is 2.9 ug/l, which does not indicate a nutrient enrichment problem.

A reduction in SOD loading to this stream of 60 percent is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. This percent is determined by assuming: stagnant flow conditions; a saturated dissolved oxygen concentration of 7.6 mg/l at 30 degrees Celsius; and assuming the ratio of the dissolved oxygen deficit under critical conditions minus the deficit attaining water quality standards to the dissolved oxygen deficit under critical conditions estimates the SOD impact on water quality. The calculation of the percent SOD reduction necessary to meet water quality standards is presented below.

Percent SOD reduction = 100 * ((DO cd) – (DO criteria deficit)) / DO cd)

DO cd = 7.6 mg/l -1.0 mg/l = 6.6 mg/l

DO criteria deficit = 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)

As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 60 percent reduction of natural SOD loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

Land Cover Daisy Creek

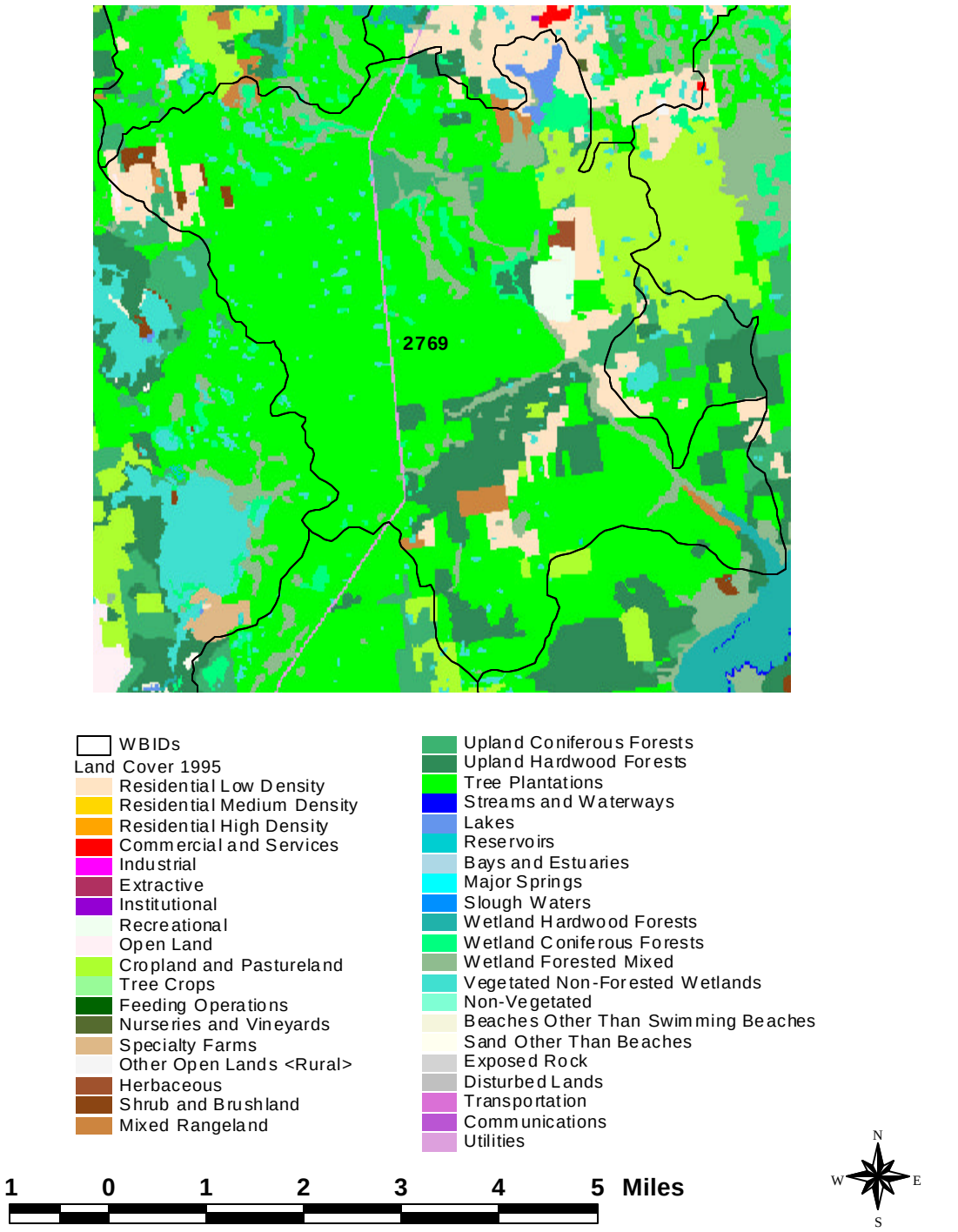

Figure 25. Daisy Creek Landuse

Table 6. Water quality observation stations in WBID 2769, Daisy Creek

Station number	Station Name	First Date	Last Date
21FLCEN 20020025	unnamed tributary at s.r. 315 just south of daisy cree	07/17/2002	09/23/2002
21FLCEN 20020026	unnamed tributary at s.r. 315 1.3 miles north of daisy	07/17/2002	09/23/2002
21FLCEN 20020118	Daisy creek 3.5 miles south of ft. mccoy; s.r. 315	07/17/2002	09/23/2002
21FLCEN 20020146	Daisy creek at gore's landing road	07/17/2002	09/23/2002
21FLSJWMOR041	Daisy creek at daisy creek rd.	04/20/1992	12/13/1993

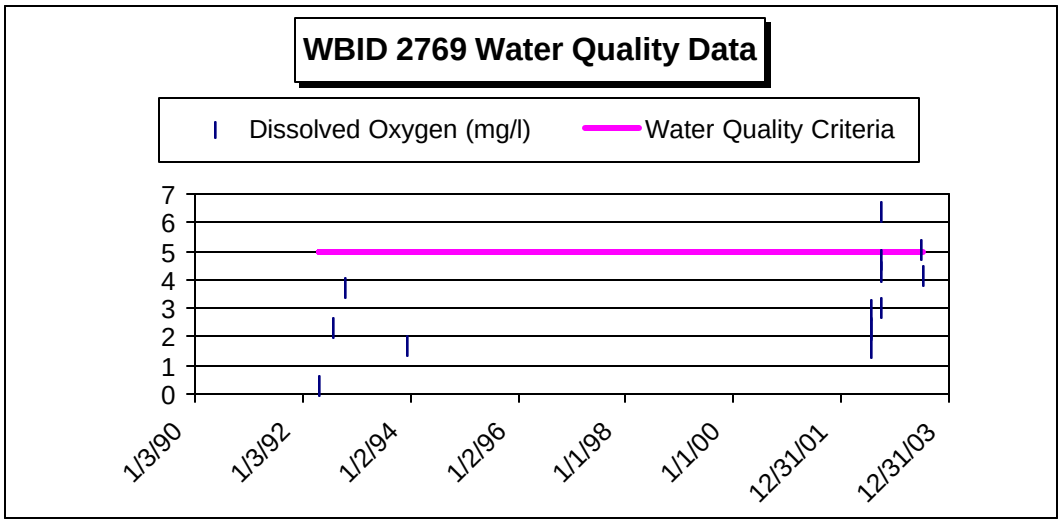

Figure 26. Dissolved oxygen concentration in Daisy Creek (WBID 2769)

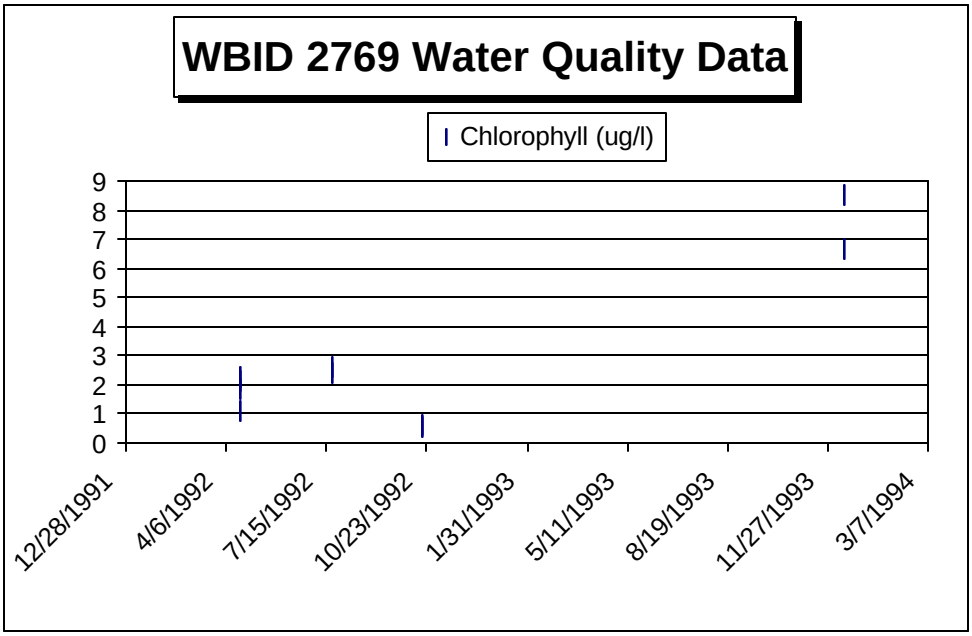

Figure 27. Chlorophyll-a concentrations in Daisy Creek

WBID #3573B Steinhatchee River

The Steinhatchee River is a black water stream that has a watershed that drains 562 square miles of southern Lafayette, southeastern Taylor, and western Dixie Counties. Ninety-eight percent of the watershed is pine flatwoods and wetlands, with some of these lands used for commercial timber production. WBID 3573B is a 43.5 square mile watershed in the upper portion of the Steinhatchee River watershed. The waterbody is a Class III freshwater stream. Land use in the WBID consists of 46 % wetlands, 44%

forest, 9% barren and extraction (includes areas of forest harvest), 0.6% rangeland, and 0.3% agriculture. This WBID was placed on the 303(d) list due to low dissolved oxygen concentrations.

The statewide criterion for D.O. in Class III freshwaters is 5.0 mg/L. The data indicate that levels of DO less than the state criterion occur at times.

Table 7. Summary of dissolved oxygen data for Steinhatchee River WBID 3573B

Parameter	Obs	Max	Min	Mean	Florida Criterion
Dissolved Oxygen (mg/l)	344	9.6	0.3	4.4	5.0 mg/L

Figure 27 shows the D.O. measurements over time. The figure 28 illustrates that there are many instances when the D.O. drops below the 5.0 mg/L criterion. There is no indication of a trend in the Steinhatchee River D.O. levels from 1987 to present.

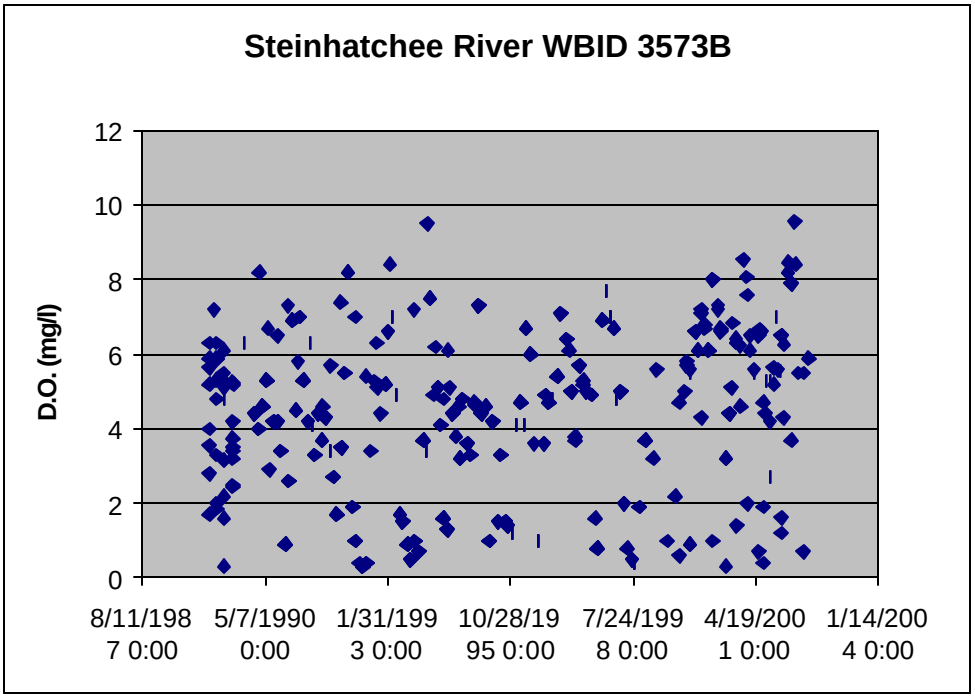

Figure 28. Steinhatchee River D.O. timeseries

Florida DEP has conducted a bioreconnaissance (BioRecon) of the Steinhatchee River at two locations. One BioRecon was conducted in the headwaters in 1999 at Highway 51 and the other was conducted further downstream in 2001 at SR 357. The results of the macroinvertebrate sampling in 1999 indicated that the community was affected by habitat

quality and low flow conditions. The 2001 BioRecon, which was conducted at a site further down the watershed, indicated that the macroinvertebrate community was in healthy condition since all three BioRecon parameters were above the threshold values. The overall habitat assessment score (131) was in the optimal range (>120) at this location. There was no visual evidence of nutrient induced imbalances *(e.g.,* algal mats, excessive macrophyte growth). The BioRecon reports are included in the Appendix.

Because invertebrates integrate effects over time, these results suggest that the low dissolved oxygen reported from this site may be a natural occurrence that has not adversely affected the biota. The Steinhatchee River has measured minimum, average and maximum D.O. values of 0.3 mg/l, 4.4 mg/l and 9.6 mg/l respectively.

Warm water temperatures, low stream gradient, and extensive riparian swamps, characterize this segment of the Steinhatchee River. The color levels of the stream range from 50 to 1000 PCU with a mean value of 346 PCU, indicating that this is a black water stream. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands of black water streams, periods of low dissolved oxygen naturally occur in stream segments that serve as outflows and drain the wetlands areas. These periods of low dissolved oxygen conditions may occur frequently in temperate black water streams (Hughes et al. 2000, FDEP 1996, Meyer and Edwards 1990, Edwards and Meyer 1987, USEPA 1986, Benke et al. 1984, Reid and Wood 1976).

A reduction in SOD loading to this stream of 64 percent is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. This percent is determined by assuming: stagnant flow conditions; a saturated dissolved oxygen concentration of 7.6 mg/l at 30 degrees Celsius; and assuming the ratio of the dissolved oxygen deficit under critical conditions minus the deficit attaining water quality standards to the dissolved oxygen deficit at critical conditions estimates the SOD impact on water quality. The calculation of the percent SOD reduction necessary to meet water quality standards is presented below.

Percent SOD reduction = 100 * ((DO cd) – (DO criteria deficit)) / DO cd)

DO cd = 7.6 mg/l –0.3 mg/l = 7.3 mg/l

DO criteria deficit = 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)

As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 64 percent reduction of natural SOD loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-

specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

WBID #3473C - Fenholloway River above Pulp and Paper Mill

Fenholloway River above pulp and paper mill is a 77 square mile watershed located primarily in Taylor County in the upper portion of the Fenholloway River watershed. The waterbody is a Class III freshwater stream. Land use in the WBID consists of 72% wetlands, 19% forest, 7% barren and extraction (includes areas of forest harvest), 1% rangeland, and 0.5% agriculture.

Fenholloway River above pulp and paper mill discharge was listed on the 1998 303(d) list for low dissolved oxygen. (D.O.) The data indicate depressed levels of D.O. do occur in the WBID. The statewide criterion for D.O. in Class III freshwaters is 5.0 mg/L.

Table 8 illustrates that the mean value of D.O. is at 4.8 mg/L, which is below the state criterion.

Table 8. Summary of dissolved oxygen data for Fenholloway River above pulp and paper mill discharge

Parameter	Obs	Max	Min	Mean	Florida Standard
Dissolved Oxygen (mg/l)	123	8.5	1.0	4.8	5.0 mg/L

The watershed is predominantly (91%) wetlands and forest and the stream is very low gradient. Warm water temperatures, low stream gradient, and extensive riparian swamps, characterize this segment of the Fenholloway River. Based on limited historical data, the color levels of the stream range from 40 to 2200 Platinum Color Units (PCU) with a mean value of 660 PCU. This indicates that this is a black water stream. Black water streams are characterized by: warm water temperatures; low stream gradients; extensive riparian swamps; and darkly stained water from tannins from decomposing organic matter such as leaf litter. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands, periods of low dissolved oxygen naturally occur in these streams that drain the wetlands areas. These types of streams may have high oxygen demands from surrounding wetlands. Regular inundation of the swamp and draining into the river contribute to the low DO in the stream. In addition, high oxygen demand from BOD in the form of organic matter and respiration from algae and other plants contribute to DO depletion. The DO depletion issue is compounded because the stream has little reaeration due to low gradient and extended periods of low flow. These periods of low dissolved oxygen conditions may occur frequently in temperate black water streams (Hughes et al. 2000, FDEP 1996,

Meyer and Edwards 1990, Edwards and Meyer 1987, USEPA 1986, Benke et al. 1984, Reid and Wood 1976). There are no point source discharges in the Fenholloway River WBID 3473C to lower the ambient D.O. levels.

A reduction in SOD loading to this stream of 60 percent is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. This percent is determined by assuming: stagnant flow conditions; a saturated dissolved oxygen concentration of 7.6 mg/l at 30 degrees Celsius; and assuming the ratio of the dissolved oxygen deficit under critical conditions minus the deficit attaining water quality standards to the dissolved oxygen deficit under critical conditions ((7.6 mg/l -1.0 mg/l =6.6 mg/l - 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)/6.6 mg/l) estimates the SOD impact on water quality. The calculation of the percent SOD reduction necessary to meet water quality standards is presented below.

Percent SOD reduction = 100 * ((DO cd) – (DO criteria deficit)) / DO cd)

DO cd = 7.6 mg/l -1.0 mg/l = 6.6 mg/l

DO criteria deficit = 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)

As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 60 percent reduction of natural SOD loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

WBID #3603 Bevins (Boggy) Creek

Bevins (Boggy) Creek is a 35 square mile watershed located in Taylor County is part of the lower Steinhatchee River watershed (see Figure 28). The waterbody is a Class III freshwater stream and was included on Florida's 1998 303(d) list with D.O. and BOD listed as parameters of concern. Land use in the WBID consists of 52% wetlands, 26% forest, 20% barren and extraction (includes areas of forest harvest), 0.1% rangeland, and 0.2% agriculture. Florida does not have a numeric criterion for BOD they assess dissolved oxygen to determine if BOD is present in excessive amounts. The statewide criterion for D.O. in Class III freshwaters is 5.0 mg/L.

Only eight data points were available for the WBID. The data are presented in Table 9. Over the evaluation period there were a total of 8 measurements of D.O. Of the observations, 7 samples exceed the criterion. Only three data points for BOD were

available and it is difficult to determine overall BOD conditions in the WBID based on this limited information. The measured BOD was not excessive and is only slightly elevated. The data indicate depressed levels of DO occur. There are no point source discharges in the Bevins Creek watershed to lower the ambient D.O. levels or increase BOD. Bevins Creek watershed is predominantly wetlands and forest and the stream is very low gradient (see Figure 29).

Table 9. Summary of D.O. and BOD data for WBID 3603

Parameter	Obs	Max	Min	Mean	StDev	Violations	Standard[1]
DO (mg/l)	8	4.0	2.1	2.8	0.62	7	5.0 mg/l
BOD (mg/l)	3	2.6	1.2	2.0			

Figure 29. Bevins (Boggy) Creek

Warm water temperatures, low stream gradient, and extensive riparian swamps, characterize this segment of the Bevins Creek. Based on limited historical data, the color levels of the stream range from 20 to 200 PCU with a mean value of 82 PCU. Only nine data points are available and the data were collected in 1989. Florida DEP reports in the BioRecon described in the following paragraph that the stream is considered a black water stream. Black water streams are characterized by: warm water temperatures; low stream gradients; extensive riparian swamps; and darkly stained water from tannins from decomposing organic matter such as leaf litter. Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands, periods of low dissolved oxygen naturally occur in these streams that drain the wetlands areas. These types of streams may have high oxygen demands from surrounding wetlands. Regular inundation of the riparian swamps and resultant draining into the stream contribute to the low DO in the stream. In addition, oxygen demand from BOD in the form of organic matter and respiration from algae and other plants is a minor contribution due to the near background levels 2.0 mg/l average observed in the stream. The DO depletion issue is compounded because the stream has little reaeration due to low gradient, frequent flow obstructions due to beaver activity, and extended periods of low flow. These periods of low dissolved oxygen conditions may occur frequently in temperate black water streams (Hughes et al. 2000, FDEP 1996, Meyer and Edwards 1990, Edwards and Meyer 1987, USEPA 1986, Benke et al. 1984, Reid and Wood 1976).

A BioRecon was conducted in 1998 by FDEP and the macroinvertebrate community was rated as poor at that time. The report stated that the likely cause for the poor scores were low water velocity (almost zero m/s), low dissolved oxygen (2.1 mg/L) and habitat smothering from organic matter. The report stated that these conditions were typical of non-flowing black water streams during the late summer. FDEP recommended that Site Specific Alternative Criteria may be necessary to establish distinct biological and water quality expectations for such stagnant, black water systems. The BioRecon report is included in the Appendix.

A reduction in SOD loading to this stream of 52 percent is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. This percent is determined by assuming: stagnant flow conditions; a saturated dissolved oxygen concentration of 7.6 mg/l at 30 degrees Celsius; and assuming the ratio of the dissolved oxygen deficit under critical conditions minus the deficit attaining water quality standards to the dissolved oxygen deficit under critical conditions estimates the SOD impact on water quality. The calculation of the percent SOD reduction necessary to meet water quality standards is presented below.

$$\text{Percent SOD reduction} = 100 * ((\text{DO cd}) - (\text{DO criteria deficit})) / \text{DO cd})$$

DO cd = 7.6 mg/l – 2.1 mg/l = 5.5 mg/l

DO criteria deficit = 7.6 mg/l – 5.0 mg/l = 2.6 mg/l)

As set out above, this information indicates that low dissolved oxygen is likely a natural condition in this stream. A 52 percent reduction of natural SOD loads in an area predominately forest and wetlands is not reasonable or achievable. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

WBID # 793A St. Marks River South

This WBID is a small WBID located in Wakulla County near the town of St. Marks. The waterbody is a Class III predominately freshwater stream. The WBID was on Florida's 1998 303(d) list for low dissolved oxygen. The statewide criterion for D.O. in Class III freshwaters is 5.0 mg/L.

Limited data are available for D.O. for the WBID. Data are available from only two locations and were taken on two separate days within a six-day period in October 2001. All the data were above the state criterion but due to its limited temporal coverage EPA is uncertain if this represents true conditions within the WBID at different times. Data from the portion of the river upstream of the site demonstrates that D.O. levels frequently drop below the criterion (177 criterion violations out of 446 samples). FDEP has currently listed this upstream segment of the St. Marks River as potentially impaired due to low D.O.

Since the St. Marks River South WBID 793A is likely influenced by conditions in the upstream portion of the watershed, EPA could not state with assurance that the WBID 793A is attaining water quality standards. The watershed contains large wetland areas and exhibits characteristics of a black water stream at times, with color levels ranging from 1 PCU to 2000 PCU recorded in the upstream areas. The color is usually less than 100 PCU with occasional excursions above 200 PCU. Only two data points were available from the WBID of concern and both were 5 PCU. The samples were taken on one day in October 2001.

Because of the high content of naturally occurring organic matter and low dissolved oxygen in waters in the associated riparian wetlands of black water streams, periods of low dissolved oxygen naturally occur in stream segments that serve as outflows and drain the wetlands areas. These periods of low dissolved oxygen conditions may occur frequently in temperate black water streams (Hughes et al. 2000, FDEP 1996, Meyer and

Edwards 1990, Edwards and Meyer 1987, USEPA 1986, Benke et al. 1984, Reid and Wood 1976).

EPA presumes a reduction in SOD loading from the wetland areas to this stream is required for the stream to meet the statewide water quality standard of no less than 5 mg/l DO. As set out above, this information indicates that low dissolved oxygen may exist periodically and is likely a natural condition in this watershed. Since the available dissolved oxygen data do not indicate impairment, it is not possible to provide an estimate of the SOD reductions necessary to meet water quality standards at all times. Therefore, EPA is proposing zero wasteload allocation and zero load allocation, except for natural background, for BOD on this creek unless or until FDEP develops site-specific alternative to establish appropriate levels of D.O. that should be maintained in the black water stream. At that time, both the impairment status of this water and this TMDL should be reevaluated.

Determination of TMDL

A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = WLAs + LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. Federal regulations provide that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. 40 CFR §130.2(i). The Dissolved Oxygen TMDLs for the waterbodies in this TMDL are expressed in terms of percent reduction of natural SOD and represent the maximum loads these waterbodies can assimilate and maintain the statewide water quality standard of no less than 5 mg/l dissolved oxygen.

Wasteload Allocations (WLAs)

The wasteload allocation provided in these TMDLs is zero, unless or until Florida establishes and EPA approves site-specific alternative criteria for the waters. At that time, both the impairment status of these waters and these TMDLs should be reevaluated.

Load Allocations (LAs)

The entire load allocation of this TMDL is allocated to natural background. All remaining nonpoint sources are allocated zero load, unless or until Florida establishes and EPA approves site-specific alternative criteria for the waters. At that time, both the impairment status of these waters and these TMDLs should be reevaluated.

Margin of Safety (MOS)

As this TMDL allocates zero load to all sources, both point and nonpoint, other than natural background, a margin of safety is not necessary in this TMDL. The allocations represent the most conservative allocations available.

Critical Conditions

The critical condition for these TMDLs is extended periods of warm weather combined with low flow. This is the condition where most exceedances are noted, and is the condition addressed by the TMDLs.

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Appendix